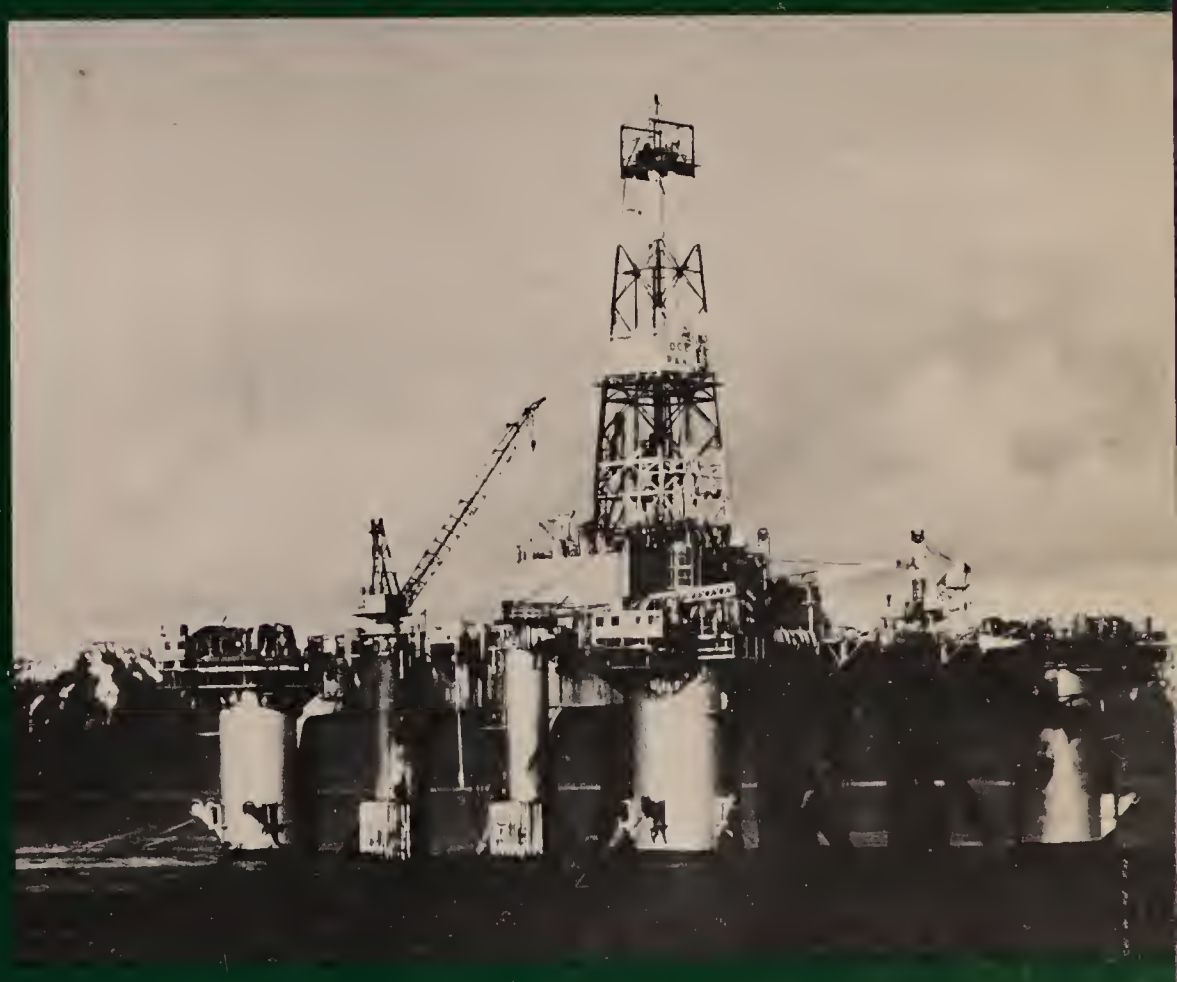
Outer Continental Shelf Oil and Gas Information Program

Gulf of Alaska and Lower Cook Inlet Summary Report 2



Prepared for the U.S. Department of the Interior, Geological Survey, in cooperation with the Bureau of Land Management

U.S. Geological Survey Open-File Report 81-607

For specific questions regarding the Summary Report, contact:

Mr. Louis G. Hecht, Jr.
Acting Chief, Office of OCS Information
U.S. Geological Survey
640 National Center
Reston, VA 22092
(703) 860-7166.

To receive Gulf of Alaska Summary Report revisions, return the postcard attached to the back cover, or write to the above address.

PUBLICATION STATUS OF OCSIP DOCUMENTS

Type of Document	Initial	Updates			Revisions	
		1	2	3	1	2
Summary Report:						
North Atlantic	7/81*					
Mid-Atlantic	11/79	6/80	2/81	8/81*		
South Atlantic	7/80	2/81	7/81*			
Gulf of Alaska	9/80				6/81	
Gulf of Mexico	9/80				7/81*	
Pacific (So. Cal.)	5/80	2/81				
Arctic	8/81*					
Indexes:						
Atlantic	5/79				2/81	8/81*
Pacific	7/79				1/81	9/81*
Alaska	7/79				1/81	11/81*
Gulf of Mexico	9/79				2/81	11/81*

*Indicates document in progress

Outer Continental Shelf Oil and Gas Information Program

Gulf of Alaska and Lower Cook Inlet Summary Report 2

June 1981

A revision of Outer Continental Shelf Oil and Gas Activities in the Gulf of Alaska (including Lower Cook Inlet) and their Onshore Impacts: A Summary Report, September 1980

By Karen M. Collins and Anne Stadnychenko

Prepared for the U.S. Department of the Interior, Geological Survey, in cooperation with the Bureau of Land Management under Contract No. 14-08-0001-19719

Rogers, Golden & Halpern, Inc.
1920 Association Drive, Reston, Virginia 22091
1427 Vine Street, Philadelphia, Pennsylvania 19102

U.S. Geological Survey Open-File Report 81-607

English-Metric Conversion

(The following table gives the factors used to convert English units to metric units and explains nautical miles and marine leagues.)

Multiply English units	by	to obtain metric units
feet	0.3048	meters
miles	1.6090	kilometers
acres	0.4046	hectares
barrels	0.1589	m3
cubic feet	0.0283	m3

1 nautical mile = 1.152 statute miles = 6,080 feet
3 marine leagues = 9 nautical miles = 10.368 statute miles

Abbreviations and Acronyms

ANCSA - Alaska Native Claims Settlement Act of 1971.
APD - Application for Permit to Drill
bbl - barrel(s)
BLM - Bureau of Land Management, U.S. Department of the Interior
bpd - barrels per day
CEIP - Coastal Energy Impact Program, administered by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce
cfd - cubic feet per day
CFR - Code of Federal Regulations
COST - Continental Offshore Stratigraphic Test
CZM - Coastal Zone Management
DEIS - Draft Environmental Impact Statement
DOI - Department of the Interior
EA - Environmental Assessment
EIR - Environmental Impact Report
EIS - Environmental Impact Statement
FO - Field Office(s), BLM
FR - Federal Register
IPP - Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities, BLM
km2 - square kilometers
LNG - liquefied natural gas
m2 - square meters
m3 - cubic meters
NEPA - National Environmental Policy Act of 1969
NOAA - National Oceanic and Atmospheric Administration
OCS - Outer Continental Shelf (Federal jurisdiction)
OCSI - Office of Outer Continental Shelf Information, USGS
PNS - Proposed Notice of Sale
RTWG - Regional Technical Working Group, BLM
SID - Secretarial Issue Document, U.S. Department of the Interior
USGS - U.S. Geological Survey, Department of the Interior

Acknowledgments

Many people have provided information and insights to the authors. All of them deserve special thanks. Larry Powell, Mayor of Yakutat, Jim Kohler, City Manager of Yakutat, Caroline Powell, Yakutat City Council President, Art Monson, Yakutat City Planner, Rick Wright of the National Oceanic and Atmospheric Administration, Paul Lowry of the U.S. Geological Survey (USGS), Phyllis Casey of the Bureau of Land Management (BLM), and Gretchen Keiser and Kurt Fredriksson, both of the Governor's Office in Alaska, were especially generous.

The Field Draft Review Committee recommended changes that improved upon early drafts. Members of this committee were Louis G. Hecht, Jr., Paul Lowry, Jeff Walker, Cass Ariey, Bruce Turner, and Charles Wilson from the USGS; and Eileen Carlton and Phyllis Casey from the BLM. Louis G. Hecht, Jr., provided overall guidance and direction of the project for the USGS. Mary Davis served as the USGS editorial coordinator.

At Rogers, Golden & Halpern, Fritts Golden provided overall project direction. Sandy Dechert designed and edited the report and supervised its production. Richard Barrett served as principal editor. Mark Yankoski directed cartography and graphics production. Mary Ann Collignon, Gene Gilroy, Sue McGuire, Valerie Smith, Pam Staubus, and Kim Tomlinson provided editorial, graphics, and technical support.

Abstract

The search for oil and gas on the Outer Continental Shelf (OCS) in the Gulf of Alaska subregion of the Alaska leasing Region began in 1967, when geophysical surveys of the area were initiated. Three lease sales have been held in the subregion. Lease Sale 39, for the northern Gulf of Alaska, was held on April 13, 1976, and resulted in the leasing of 76 tracts. Lease Sale CI, for Lower Cook Inlet, was held on October 27, 1977, and resulted in the leasing of 87 tracts. Lease Sale 55, held on October 21, 1980, resulted in the leasing of 35 tracts in the eastern Gulf of Alaska. Exploratory drilling on the tracts leased in Sale 39 began in September 1976, and exploratory drilling on tracts leased in Sale CI began in July 1978. Drilling stopped on Lease Sale 39 tracts in July 1978 and on CI tracts in June 1980. No additional applications for permit to drill have been submitted for either area. Exploratory drilling is expected to begin on tracts leased in Sale 55 in the spring or summer of 1982.

Commercial amounts of hydrocarbons have not been found in any of the wells drilled in either the Sale 39 or Sale CI areas. As of February 1981, 75 of the 76 leases issued in the northern Gulf of Alaska have been relinquished, and 18 of the 87 CI leases have been relinquished. The next lease sale in the Gulf of Alaska, Sale RS-1 (a reoffering sale), is scheduled for late June 1981. Lease Sale 60 (Lower Cook Inlet and Shelikof Strait) is scheduled for September 1981.

The most recent estimate by the U.S. Geological Survey (USGS) of risked, economically recoverable resources for the one tract currently under lease in the northern Gulf of Alaska is that they are negligible. For the 35 tracts currently under lease (plus two tracts offered but not leased) in the northeastern Gulf of Alaska, the USGS has estimated risked, economically recoverable resource estimates of 12.6 million barrels of oil and 45.4 billion cubic feet of gas.

Onshore impacts from OCS exploration in the Gulf of Alaska have been minimal. Two communities--Yakutat and Seward--served as support bases for past northern Gulf of Alaska exploration efforts. Kenai and Homer provided support for the exploratory drilling in Lower Cook Inlet. Yakutat will serve as the support base for Sale 55 exploration activities.

Contents

Illustrations

Tables

Introduction

This report, **Gulf of Alaska and Lower Cook Inlet Summary Report 2,** is a revision of the first Gulf of Alaska Summary Report (Jackson and Dorrier, 1980). This document may be used in conjunction with the earlier report, which provided baseline information on oil and gas activities in the Gulf of Alaska/ Lower Cook Inlet region. An attempt has been made not to duplicate material presented in the previous report unless the inclusion of such material is essential to the discussion at hand. The summary report is designed to assist State and local planners and other officials in the Gulf of Alaska region to plan for the onshore effects of OCS oil and gas development. This is achieved by describing the OCS-related activity that has occurred recently and by projecting the level of near-term activity (approximately 6 months). The information presented in the summary report represents data collected from Federal agencies, OCS-related studies, and Office of OCS Information staff discussions with Federal, State, and local officials, and with other interested parties as well.

Since publication of the initial Gulf of Alaska report, OCS Lease Sale 55 was held. For this reason, this report focuses on the Sale 55 area. It is preceded by reports on the Mid-Atlantic, Pacific (Southern California), South Atlantic, Gulf of Alaska (including Lower Cook Inlet), and Gulf of Mexico. Summary Reports for the North Atlantic and Arctic (U.S.) Regions, along with a revision of the Gulf of Mexico Summary Report, will be published in the summer and fall of 1981. Indexes of information used by the Federal Government in its OCS decisionmaking process are also available. The index for Alaska is currently in press.

The Alaska OCS comprises 74 percent of the total area of U.S. offshore lands because of its 6,636-mile (10,686-km) coastline and the wide extent of the Continental Margin surrounding the State. The size of the Alaska OCS and the unique environmental conditions in Alaska make it practical to divide the leasing region. The U.S. Geological Survey (USGS) Conservation Division has therefore divided the State into three subregions (fig. 1) for purposes of developing OCS operating orders--the Gulf of Alaska (including Lower Cook Inlet), the Bering Sea, and the Arctic. To date, OCS Orders have been prepared for the Gulf of Alaska and the Arctic (USGS, 1980, and USGS, 1981). The Bureau of Land Management has divided the State into 15 proposed planning units for administrative purposes. Due to the number of lease sales scheduled for the State, the Office of OCS Information will prepare separate reports for each of the three Alaska subregions as designated by USGS. This summary report deals with OCS-related activity in the Gulf of Alaska.

Alaska has a long history of involvement with oil and gas onshore and in State waters. As early as 1853, while Alaska was owned by Russia, there were reports of petroleum in the Cook Inlet area. Claims were staked as early as 1892, and it is believed that the first drilling occurred in 1898 (Barry, 1973). Yet it was not until 1902, in the Gulf of Alaska upland area near Katalla, that a commercial discovery was made. Production continued until 1933, when the small refinery was destroyed by fire. The wells were plugged (shut in). In 1957, another commercial discovery was made on the Kenai Peninsula, in the Swanson River area, by the Richfield Oil

FIGURE 1.—Gulf of Alaska, Bering Sea, and Arctic subregions. (Jackson and Dorrier, 1980.)

Corporation. In 1962, the Pan American Petroleum Corporation discovered oil in State waters in Upper Cook Inlet, and by 1969 two refineries had been built at Nikiski, just north of Kenai. There are presently 14 platforms producing oil and gas from State-leased offshore areas in Upper Cook Inlet.

Four Alaska **Outer Continental Shelf** lease sales have been held. Three of these have been in the Gulf of Alaska subregion. Lease Sale 39, for the northern Gulf of Alaska, was held in Anchorage on April 13, 1976, and of the 189 tracts offered 76 tracts were leased, totaling 409,058 acres (165,543 hectares). The second sale (Lower Cook Inlet, Lease Sale CI), also held in Anchorage on October 27, 1977, offered 135 tracts and resulted in the leasing of 87 tracts, totaling 495,307 acres (200,448 hectares). Exploratory drilling on the tracts leased in Sale 39 began in September 1976, and exploratory drilling on tracts leased in Sale CI began in July 1978. No commercial discoveries have been made in either lease sale area to date. The third lease sale in this area, Lease Sale 55 in the Gulf of Alaska, was held on October 21, 1980, in Anchorage. Of the 210 tracts offered, bids were accepted for 35. Exploration of these tracts is expected to begin in the spring of 1982.

The fourth sale held in Alaska was the Federal/State Joint Beaufort Sea Oil and Gas Lease Sale (Sale BF). This sale was conducted in Fairbanks on December 11, 1979. Because of litigation, the bids were not accepted until July 10, 1980. A summary report of the events pertinent to this sale will be available in September 1981.

A number of other OCS lease sales are scheduled to take place in the Alaska Region. The 5-year OCS oil and gas leasing schedule for Alaska, approved in June 1980, is given in figure 2, and the areas proposed for lease are shown in figure 3. One lease sale, plus a reoffering sale, is scheduled for the Gulf of Alaska subregion. Lease Sale 60, in the Lower Cook Inlet and Shelikof Strait area is scheduled for September 1981. A reoffering sale, RS-1, is tentatively scheduled for June 1981 and will offer for lease 175 tracts, 173 of which were offered but not bid on in Lease Sale 55. The other two tracts were bid upon, but the bids were rejected as too low. Lease Sale 61, off Kodiak Island, was deleted from the draft proposed 5-year OCS oil and gas leasing schedule, dated April 1981, which is presently being evaluated by the Department of the Interior (DOI). Therefore, all pre-lease sale activities for this sale have been terminated.

The Gulf of Alaska Summary Report is designed to assist State and local officials in planning for future OCS activity. The report contains descriptions of the OCS-related activity that has occurred since publication of the initial summary report and projects foreseeable activity. The Office of OCS Information staff is available to consult with State agencies if additional information or clarification is desired (telephone: (703) 860-7166). Limited technical assistance on a case-by-case basis is available from the Office of OCS

Pursuant to Section 18 of the OCS Lands Act Amendments of 1978, the Secretary of the Interior will annually review and revise the OCS oil and gas leasing program. Revisions to the program are currently under way to streamline lease sale preparation procedures, to offer areas of high potential earlier, and to offer more acreage for leasing.

A proposed new 5-year leasing schedule will be published in June 1981, and a final schedule is expected to be approved late this year or early in 1982. Until the final schedule is approved, all lease sale dates noted in this report are based on the June 1980 final 5-year oil and gas leasing schedule. However, pre-sale steps for lease sales under way may be changed to reflect streamlining and may not match those shown on the June 1980 schedule.

The Department of the Interior has scheduled five annual **reoffering sales** during the period 1981-1985. These sales will reoffer for lease those tracts offered in the previous calendar year outside the Gulf of Mexico for which bids were not received or for which high bids were rejected as being inadequate. RS-1 is the first reoffering sale and will reoffer tracts in the Lease Sale 55 Gulf of Alaska area.

Information to assist States in improving their abilities to plan for the effects of onshore development related to OCS oil and gas development.

Each summary report produced by the Office of OCS Information begins with a chapter presenting the most recent OCS oil and gas resource and reserve estimates. The magnitude and timing of OCS activity are discussed in chapter 2 of the report. The third chapter

PROPOSED SALE AREA	PROPOSED DATE	1980 J F M A M J J A S O N D	1981 J F M A M J J A S O N D	1982 J F M A M J J A S O N D	1983 J F M A M J J A S O N D	1984 J F M A M J J A S O N D	1985 J F M A M J J A S O N D
RS-1 Gulf of Alaska	6/81		P S_C R N S				
60 Cook Inlet	9/81	E H	F P S_C R N S				
57 Norton Basin	9/82	T	E H	F P S_C R N S			
70 St. George Basin	12/82	T	E	H F P S_C R N S			
71 Beaufort Sea	2/83	T	E	H F P S_C R N S			
* 61 Kodiak	4/83	C D	T	E H F P S_C R N S			
75 No. Aleutian Shelf	10/83	C D T		E H F P S_C R N S			
83 Navarin Basin	12/84		C D	T	E	H F P S_C R N S	
☆ 85 Chukchi Sea	2/85		C D	T	E	H F P S_C R N S	
86 Hope Basin	5/85		C D	T		E H F P S_C R N S	

C – Call for Nominations
D – Nominations Due
T – Tentative Tract Selection
E – Draft Environmental Statement
H – Public Hearing
F – Final Environmental Statement
P – Proposed Notice of Sale
S_C – State Comments Due
R – Energy Review
N – Notice of Sale
S – Sale

☆ The holding of the Chukchi Sale at this time is contingent upon a reasonable assumption that technology will be available for exploration and development of the tracts included in the sale.

* In April 1981, the Secretary of the Interior deleted the proposed offering for Sale 61

FIGURE 2.—Current 5-year oil and gas leasing schedule for Alaska (June 1980). (BLM, 1980c.)

FIGURE 3.—Basins of proposed and existing lease sales in Alaska, 1980-1985. (Adapted from Jackson and Dorrier, 1980, by Rogers, Golden & Halpern.)

presents information on oil and gas transportation strategies, including those that are developed as part of the BLM's ongoing Intergovernmental Planning Program (IPP). Chapter 4 describes the nearshore and onshore activities that are occurring and/or probably will occur as a result of current and projected offshore activity for each of the lease sales. Appendixes provide further detail, and a glossary presents definitions of geologic, industry-specific, and other special terms used in the report.

Resource and reserve estimates presented in the summary report reflect the most recent Federal Government information. Other information contained in this report is based in part on data collected by Federal agencies in the course of planning, leasing, and managing the Gulf of Alaska OCS, as well as information on OCS activities that was prepared outside the Federal Government.

In the course of preparing this report, representatives of the Office of OCS Information discussed Gulf of Alaska OCS activities with Federal officials, oil industry representatives, and State and local officials. Concerns voiced in these interviews and additional research resulted in the identification of issues that are treated in this summary report.

A continuing concern of State and local officials in the Gulf of Alaska subregion is the nature and magnitude of onshore facilities that may be located in or otherwise affect their communities as a result of offshore development. Central to this concern is

whether or not the Gulf of Alaska has oil and gas in commercial quantities. The summary report presents a background for discussion of this issue by explaining what resource estimates mean, how they are derived, what they can be used for, and how the process of estimating resources relates to the process of exploring for oil and gas. This explanation of the nature of resource estimates provides a basis for understanding some of the uncertainties concerning the OCS-related activity in the Gulf of Alaska.

As exploration of the Outer Continental Shelf in the Gulf of Alaska continues, our knowledge of the subregion's resource potential will improve. Future editions of the summary report or summary report updates will include the most recent resource and reserve estimates, anticipated production curves, transportation strategies, and descriptions of existing and anticipated nearshore and onshore support activity and production facilities.

1. Offshore Oil and Gas Resources of the Gulf of Alaska

Offshore oil and gas resources within a region result from its geologic history and structure. This chapter discusses the geology of the Outer Continental Shelf in the Gulf of Alaska subregion. An overview of geologic structures is provided in the first section, and locations are identified for Lease Sale 55 and proposed Lease Sale 60. The next section summarizes geologic features affecting petroleum exploration and development in the northeastern Gulf of Alaska and compares the geology of Lease Sales 39 and 55. The third section of the chapter provides a discussion of various procedures used by the Federal Government to estimate hydrocarbon potential. The most recent information available on oil and gas resources and reserves in the Lease Sale 55 area (northeastern Gulf of Alaska) is provided in the final section of the chapter. The area's geologic setting is presented in detail in appendix A.

OVERVIEW OF THE GEOLOGY OF THE SUBREGION

The Gulf of Alaska subregion is contained within two geologic provinces: the Pacific-Margin Tertiary Province and the Alaska Peninsula-Cook Inlet Province. Figure 4 shows the extent of these two petroleum provinces.

The Pacific-Margin Tertiary Province extends over 900 miles (1,448 km) from south of Kodiak Island, in the western Gulf of Alaska, to Cross Sound, in the eastern Gulf. Plafker (1971) estimated that 40,000 square miles (103,594 km2) of onshore and offshore lands within the province are underlain by Tertiary rocks, which are potential source rocks for petroleum deposits. The Gulf of Alaska Outer Continental Shelf comprises 85 percent of this area. Tracts leased in Sale 55 are located on the northeastern portion of the OCS; most of this area has a water depth of less than 660 feet (200 m). Subsurface structures that could serve as potential hydrocarbon traps are present on these offshore lands (Von Huene, Lathram, and Reimnitz, 1971). However, no commercial discoveries of hydrocarbons have been made to date in offshore areas of the Pacific-Margin Tertiary Province.

The proposed Lease Sale 60 area in Lower Cook Inlet - Shelikof Strait is part of the 30,000 square-mile (77,695 km2) Alaska Peninsula - Cook Inlet petroleum province. As shown in figure 4, the province extends from the Copper River Basin southward across Cook Inlet to the Alaska Peninsula. This basin includes a long, narrow wedge of moderately deformed clastic rocks of late Mesozoic and Tertiary age. Commercial accumulations of oil and gas are present in the Tertiary rocks in this basin. These Tertiary rocks, and possibly upper Mesozoic rocks, are believed to have the best potential for future hydrocarbon discoveries (Gryc, 1971).

GEOLOGIC ASPECTS OF THE NORTHERN GULF OF ALASKA

The northern Gulf of Alaska OCS is located in the northeastern area of the Pacific-Margin Tertiary Province. The OCS part of the province comprises approximately 20,000 square miles (51,797 km2) of offshore lands. Major physiographic features of the OCS in

FIGURE 4.—Petroleum provinces of Alaska. (Jackson and Dorrier, 1980.)

the northern Gulf of Alaska are shown in figure 5. The width of the Continental Shelf varies from 8 miles (13 km) at the eastern end of the area to 65 miles (105 km) in the west. The surface of the OCS is gently undulated, with six submarine valleys separating extensive shelf areas. These subsea valleys are remnants of glaciation.

The segment of the OCS that generates the most interest is the Yakutat Shelf, situated in the northeastern Gulf of Alaska, between Icy Bay and Dry Bay. The Yakutat Shelf is geologically bounded by deformed Tertiary strata and the Fairweather Fault to the north and east, the Continental Slope and Transition Fault Zone on the south, and by a broad zone of geologically young faults and folds, termed the Pamplona Fault Zone, on the west (fig. 6). A portion of this area was leased during Sale 55. It is the second OCS area in the northern Gulf of Alaska where exploratory drilling will occur. Exploratory drilling in the first area, the Lease Sale 39 tracts on the Yakataga Shelf, has failed to encounter commercial deposits of hydrocarbons.

Although there has been no continental offshore stratigraphic testing (COST) by the oil industry for Lease Sale 55, data samples from ocean-bottom dredging have been collected and analyzed by U.S. Geological Survey (USGS) geologists (Plafker and others, 1980). One COST well was drilled in the northern Gulf of Alaska during Lease Sale 39, approximately 125 miles (201 km) west of Yakutat. Dredging samples have indicated that a previously unrecognized sequence of rocks on the

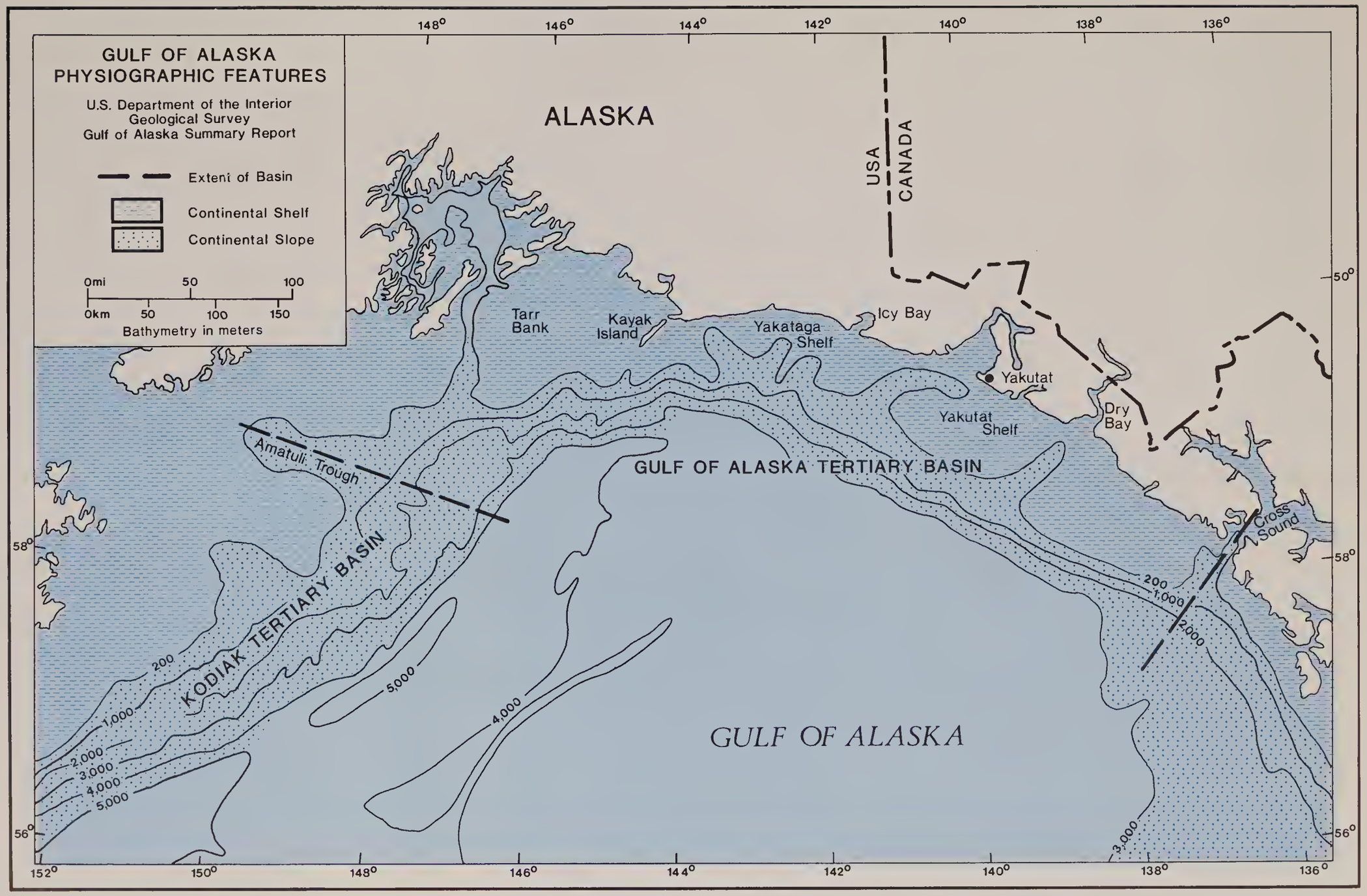


FIGURE 5.—Major physiographic features of the OCS in the northern Gulf of Alaska. (Jackson and Dorrier, 1980.)

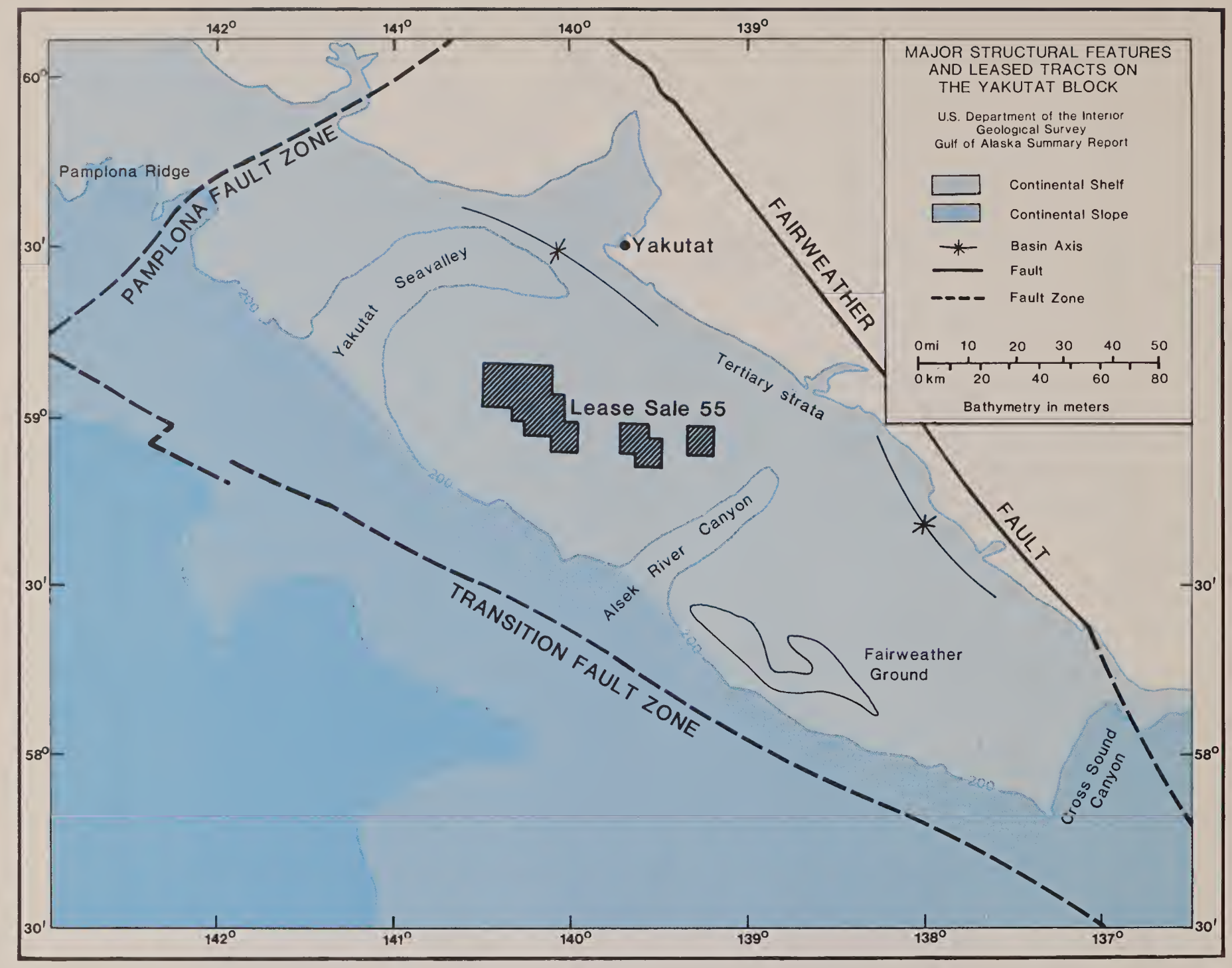


FIGURE 6.—Major structural features and leased tracts (Lease Sale 55) on the Yakutat Block. (Adapted from Plafker and others, 1980, by Rogers, Golden & Halpern.)

Continental Slope extending beneath the OCS Lease Sale 55 area contains sufficient organic material to have generated petroleum. The bedded rock sequence sampled on the slope had not been previously recognized because it was not present in any onshore outcrops or in wells previously drilled for oil along the Pacific-Margin Tertiary Province. Furthermore, the sequence is buried by younger rocks on the Continental Shelf. Sections penetrated by exploratory wells in the nearby Lease Sale 39 area bear little resemblance to the Yakutat Shelf geology; hydrocarbon traps in the Lease Sale 55 area are likely to be more subtle. At least one structural high, however, has been detected on available seismic data. This anticlinal structure, lying at a depth of about 13,000 feet (3,962 m) (Oil and Gas Journal, October 27, 1980), is composed of rocks older than those in the nonproductive area to the west. Tracts located on the anticline received considerable interest during the 1980 lease sale, indicating a potential hydrocarbon accumulation of considerable size.

Geologic differences between the areas already explored by drilling and the Yakutat Shelf and Slope suggest that in order to obtain

a meaningful petroleum assessment, this area must be judged by its merits rather than by comparison with better explored but possibly dissimilar areas elsewhere (Plafker and others, 1980).

The Yakutat district of the Pacific-Margin Tertiary Province is part of a continuous seismically and volcanically active belt located along the Pacific-North American plate boundary. During the last 80 years, there have been several earthquakes in this area with a magnitude of 7.5 or greater on the Richter Scale. These earthquakes in this area and their aftershocks relieve energy stress over sharply limited regions (NOAA, 1980). Regions not having experienced a large earthquake for a long period of time are known as **seismic gaps.** It is generally considered that seismic gaps are the most likely sites for a future major earthquake (BLM, 1976). The February 28, 1979, St. Elias earthquake (magnitude 7.7), located in this geologically complex zone along the North American and Pacific plates, was the first major event since 1900 to occur in a seismic gap between the 1958 Fairweather Fault earthquake (magnitude 7.9) and the 1964 Prince William Sound earthquake (magnitude 8.5) (Stephens, Lahr, and others, 1980) (fig. 7). The shock of the St. Elias earthquake ruptured only a small part of the existing gap. The remaining area between Icy Bay and Kayak Island, informally called the Yakataga Seismic Gap, may have sufficient strain stored to generate a great shock that could potentially damage the Yakutat district and its oil and gas activities in the future (Davies, 1981, oral commun.). Although the gap hypothesis should be applied with caution in this tectonically complex and unusual region, the history of plate uplift and movement makes the northern Gulf of Alaska an important area in which to continue geologic hazard studies. Destruction to either offshore or onshore facilities could result from earthquake-related hazards such as tsunamis (seismic sea waves), landslides, ground breaking and shaking, avalanches, and mud flows. The relatively high frequency of earthquakes in the Gulf of Alaska also suggests that future differential movements of the sea floor are probable (BLM, 1980a).

Analyses of the geophysical and sedimentological data collected for Lease Sale 55

Plate tectonics is a theory of global scale dynamics involving the movement of many rigid plates of the earth's crust. Considerable tectonic activity occurs along the margins of the plates where buckling and grinding occurs as the plates are propelled past or toward each other by the forces of deep-seated mantle convection currents. This has resulted in continental drift and changes in shape and size of oceanic basins and continents.

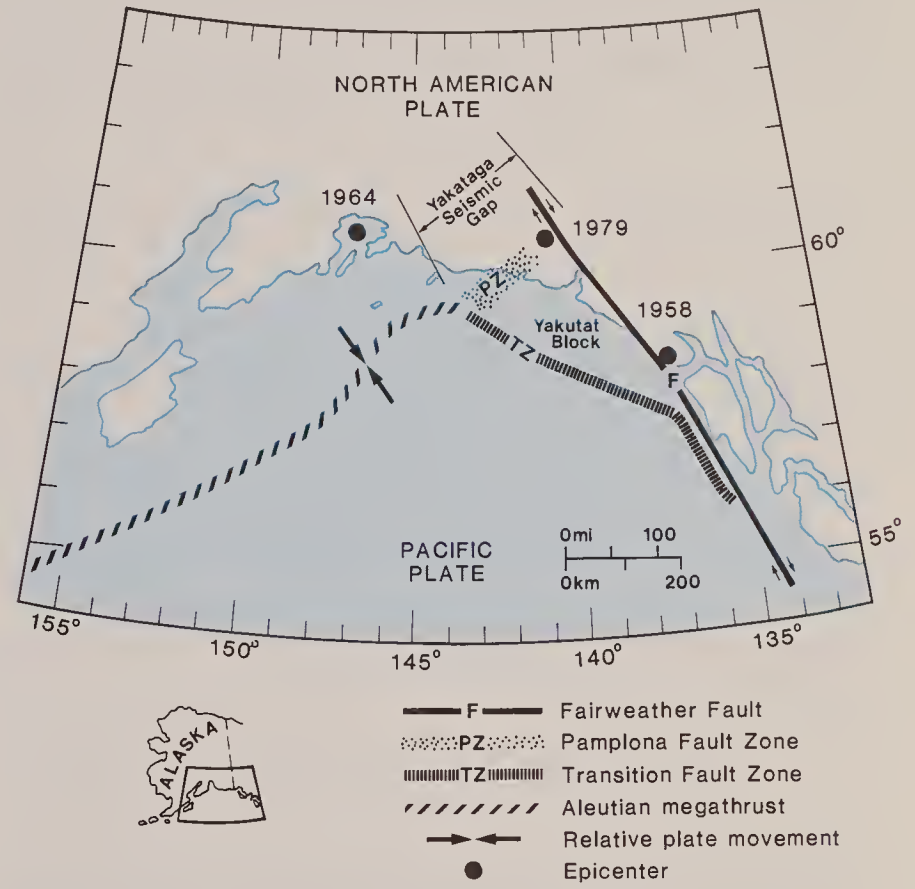


FIGURE 7.—Pacific and North American plates and epicenters of the 1964 Prince William Sound earthquake, the 1958 Fairweather Fault earthquake, and the 1979 St. Elias earthquake. (Adapted from Plafker and others, 1980, by Rogers, Golden & Halpern.)

indicate that the geologic hazards present are related to seismicity, mass movement, and gas-related features (Turner and others, 1981). Although none of the leased tracts in Sale 55 contain bottom conditions where mass movement and gas indicators exist, slumping conditions have been identified in areas of possible future pipeline routes leading from active lease areas to the shore.

Other potential geologic hazards in the northern Gulf area may include high-pressured, gas-charged sediments; high rates of

sedimentation; and onshore glacial-lake breakouts.

Environmental and geologic hazards in the Lease Sale 55 area constitute OCS development issues. Failure to identify and avoid these hazards, or to take proper engineering precautions against them, could result in damage to platform, pipeline, or onshore facilities. The conditions may require post-sale decision-making concerning development plans and siting and design procedures (Jackson and Dorrier, 1980).

ESTIMATING HYDROCARBON POTENTIAL

Estimating hydrocarbon potential is a complex process. Until a well has been drilled, investigators derive all their knowledge of subsurface geology indirectly, from geologic and geophysical data collected at the surface. It is extremely difficult to estimate how much oil and gas are in the ground in any given area until that area has been extensively explored by drilling.

There has been no exploratory drilling in the northeastern Gulf of Alaska (Sale 55 leases) yet, so the hydrocarbon potential cannot be proven, but only estimated in terms of resources. Estimates of resource potential are inherently speculative, particularly in areas where geologic information is limited and the presence of oil and gas has not been demonstrated.

Undiscovered resources are quantities of oil and gas that have been postulated to exist outside known fields. Estimates of undiscovered resources are made by identifying areas of resource potential on the basis of broad geological knowledge and theory. Using available data as a basis for further investigations, petroleum geologists then conduct a variety of geologic assessments of the region. An **undiscovered recoverable resource** is an estimate of resources that can be extracted economically under existing technology and price/cost relationships, assuming normal short-term technology growth (Dolton and others, 1981). This figure provides a regionally based estimate of the possible amounts of recoverable oil and gas in a broad area (e.g., the Gulf of Alaska). Once the leasing process begins and tracts are selected for environmental study and analysis, this estimate is refined to one that represents the possible amounts of resources that may exist in tracts subject to these studies.

Two kinds of estimates are produced for study purposes in the pre-leasing process: a **conditional resource estimate** and a **risked recoverable resource estimate.** A conditional resource estimate is developed for an environmental impact study (EIS). This estimate assumes that favorable geologic conditions exist such that oil and gas are present and are contained in traps within the proposed sale area in commercial quantities. The possibility that the area is devoid of all oil or gas in commercial quantities is not considered in this estimate (BLM, 1980a). Based on this estimate, scenarios of exploration, development, and production activities are developed. These scenarios are then evaluated in terms of their potential impacts.

Conditional or risked resource estimates produced for a lease sale are probabilistic in nature. These estimates are generated by a computer simulation model that uses the available geologic and engineering data and allows the uncertainty associated with various reservoir parameters to be incorporated in the estimate. For purposes of leasing acreage on the OCS, an EIS details three estimates: (1) a low estimate with a 95 percent chance of occurrence, (2) a high estimate with a 5 percent chance of occurrence, and (3) a statistical mean calculated on the computer.

In estimating resources, assumptions are often made in order to account for uncertainties. For example, a resource estimate conditioned by the word recoverable takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface. An estimate of economically recoverable resources takes into account the costs of exploration, development, transportation, and the market prices of oil and gas. A third uncertainty stems from the probability that resources are, or are not, present in a given area. A risked resource estimate is one that has been modified according to the estimator's assessment of the probability that economically recoverable resources will actually be encountered within the area of interest.

The risked recoverable resource estimate takes this process one step further by incorporating a sale area risk factor. The effect this step has on the estimate is to lower it by some amount because of the risk that oil or gas may not be present in commercial quantities (for more information see appendix B of the initial summary report). The risked recoverable resource estimates are developed prior to the notice of sale. They are provided to the Secretary of the Interior to assist him in deciding which tracts will be offered for sale and which stipulations will apply.

Another computer simulation model is used to derive a resource economic value for each tract so that the Government can efficiently evaluate the bids received at a lease sale. This model considers the degree of uncertainty associated with various economic and engineering parameters. These techniques yield a range of resource economic values for the tract, and the statistical mean of this range is used as an aid to determine bid adequacy.

The procedures described above are currently in effect. However, the Department of the Interior is considering the adoption of certain proposed, streamlined procedures that would allow additional acreage to be offered for sale. As these changes in procedures are proposed, the Office of OCS Information will summarize them in future summary reports.

After a discovery is made and the commercial potential of a reservoir has been established, petroleum geologists are able to calculate **reserves.** Reserve estimates are estimates of the portion of the identified resource that can be economically extracted. A preliminary reserve calculation might be based on information obtained from one or several wells and from maps of the subsurface geology. Estimates of reserves allow us to approximate more closely the level of development activity that can be expected in an area than do conditional or risked estimates of economically recoverable resources.

Once a commercial discovery has been made, site-specific planning for OCS development and production that a State and local government undertake should be based on reserve estimates. However, in the absence of a commercial discovery, the most appropriate figure to use is the estimate of **risked, economically recoverable resources.** Although considered less accurate than the reserve estimate due to insufficient exploratory data, it is the most useful resource estimate for general--as opposed to site specific--planning because it has been modified by the likelihood of any discovery being commercially attractive.

RESOURCE AND RESERVE ESTIMATES FOR THE GULF OF ALASKA

The USGS's latest resource and reserve estimates for the Gulf of Alaska and for offshore areas currently under lease in the Lease Sale 55 area (northeastern Gulf of Alaska) are presented in table 1. Exploration on leases in the northern Gulf of Alaska (Lease Sale 39 tracts) and Lower Cook Inlet (Lease Sale CI tracts) has so far failed to yield any proven fields of oil or gas. Exploration activities in these leased areas have ceased and no future exploratory drilling is contemplated. Thus, resource estimates for these two areas are not provided (the initial summary report provides the latest resource estimates).

The undiscovered recoverable resource estimates for the Gulf of Alaska are given in the first line of the table. They provide a measure of the petroleum potential of the geological basin. It is important to understand that these estimates are based on interpretation of broad-scale geologic data and therefore provide only a preliminary approximation of the total hydrocarbon potential of this OCS area.

The risked estimates of economically recoverable resources are given next. They cover only Sale 55 leased tracts (35 tracts) plus two offered, but not leased, tracts. The estimates are based on the assumption that the potential geologic traps that have been identified contain risked, economically recoverable quantities of hydrocarbons.

The relatively small size of the risked mean resource estimate can be misleading. Incorporated in the derivation of this estimate is the probability that recoverable hydrocarbons do not exist in the leased area in

TABLE 1.—Gulf of Alaska OCS oil and gas mean resource and reserve estimates

	Oil (million barrels)	Gas* (billion cu ft)
Undiscovered recoverable resources		
Gulf of Alaska (water depth 0-2,500 m)	400	2,200
Risked, economically recoverable resources		
Gulf of Alaska leased lands (35 leased tracts and 2 rejected tracts in Lease Sale 55)	12.6	45.4
Reserves		
Eastern Gulf of Alaska	0	0
Gulf of Alaska	0	0

*Associated (with oil) gas and nonassociated gas.

SOURCES: Dolton and others, 1981 (undiscovered recoverable resource estimates); Lynch, 1981, (risked, economically recoverable resource estimates and reserve estimates.)

commercial quantities. The conditional mean resource estimate for the Gulf of Alaska is 450 million barrels (72 million m3) of oil and 1,250 billion cubic feet (35.4 billion m3) of gas; these estimates are based on the assumption that recoverable volumes of oil and gas exist in the leased area.

Since no exploratory work has been accomplished in this frontier area, there is a better likelihood of finding larger fields than there would be in mature producing areas. However, there is generally a correspondingly higher degree of risk and uncertainty associated with finding commercial quantities of hydrocarbons in frontier regions. The probability of finding commercial volumes of hydrocarbons can be shown by comparing the risked mean estimates to the conditional estimates mentioned above.

Only through exploratory drilling will the actual resource potential of the tracts leased in Sale 55 become known. The Office of OCS Information will provide information on the results of exploration drilling in future editions of this summary report.

Reserve estimates approximate the cumulative production that can be expected from an actual discovery. The entry for reserves is zero at this time for both the northeastern Gulf of Alaska OCS and the entire Gulf of Alaska OCS because no discovery of oil or gas in commercial amounts has yet been made.

2. Magnitude and Timing of Offshore Development

This chapter provides a summary of the offshore activities in areas leased in Sale 55 to date and those anticipated during the next 6 to 12 months for the northeastern Gulf of Alaska areas. Also discussed are events that may result from Lease Sale RS-1, scheduled to be held in late June 1981.

LEASE SALE 55

In January 1978, the Bureau of Land Management (BLM) requested resource information on the eastern Gulf of Alaska area from several Federal and State agencies. The data provided in these resource reports formed the basis for the environmental impact statement (EIS) and secretarial issue document (SID) for Lease Sale 55. In May 1978, BLM invited the oil industry and other parties to nominate blocks of submerged land for inclusion in the proposed lease area. The public was also afforded the opportunity to comment on proposed leasing activities in the area. Sixteen comments were received from the public and government agencies in response to the call. Three companies responded, and 389 of the 1,861 blocks under consideration off the coast of Yakutat were nominated for lease. After the nominations and comments were received and reviewed, 350 blocks (1.95 million acres or 0.8 million hectares) were selected for further study in an EIS.

In September 1979, a draft EIS was published, and hearings on it were held in Yakutat and Juneau in October. The final EIS incorporated comments from these hearings and was released in March 1980. Based on the State's recommendations and environmental analyses, 140 blocks were deleted prior to the sale to provide additional protection to marine, coastal, and human environments. The final notice of sale, published September 10, 1980, offered for lease 210 tracts (1.2 million acres or 0.49 million hectares) in the northeastern Gulf of Alaska. A summary of reasons behind tract deletions as well as sale stipulations are discussed below.

Major Issues, Tract Deletions, and Lease Stipulations

The major environmental and socioeconomic issues raised at the EIS scoping meetings and public hearings preceding Lease Sale 55 were as follows:

- impacts on maintenance of the lifestyle of Yakutat's people,
- impacts on the local economy of Yakutat,
- impacts on fisheries resources,
- impacts on endangered and threatened species,
- impacts on cultural and historic resources, and
- impacts on air and water quality.

> The words "block," "lease," and "tract" have discrete definitions and applications. The word **block** is used to refer to a geographical area as portrayed in official BLM protraction diagrams or leasing maps. A block in the Alaska Region generally contains 5,693 acres (2,303 hectares). **Lease** is used to mean a contract authorizing exploration for and development and production of minerals on the submerged lands covered by such a contract. A **tract** is the geographic and legal extent of a single leased area; it is a convenient way of numbering blocks offered for sale.

In response to these concerns, and after detailed analysis in the EIS, 140 tracts were deleted prior to the sale, including 5 tracts close to ecologically sensitive areas. Generally, the tracts deleted were in the northeastern, nearshore segment, and the northwestern portion of the area initially proposed for lease. Figure 8 shows tracts deleted from Lease Sale 55. Deletion of these tracts had the following effects:

- reducing the possible deleterious impact on the benthic invertebrates whose habitat is the inner shelf (where water depths are less than 328 feet (100 m));
- reducing the chance that oil spills from blowouts or platform fires would reach nearshore habitats;
- reducing potential negative impacts on fish species in the Yakutat area; and
- reducing potential negative impacts on migrating cetaceans (whales).

These tracts were deleted mainly to reduce the possibility of an oil spill reaching nearshore critical habitats of such species as salmon, clams, herring, crab, and some bot-

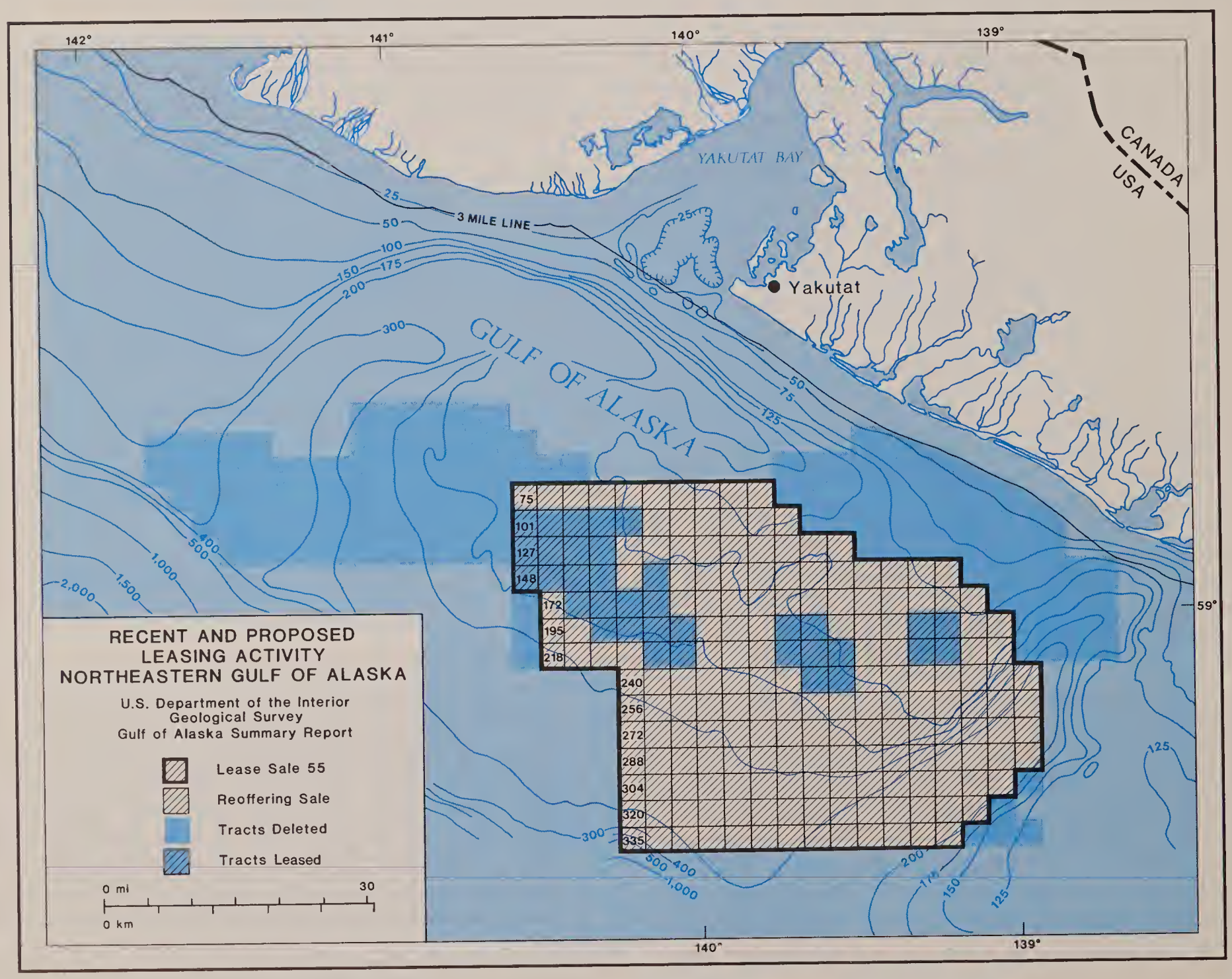


FIGURE 8.--Tracts deleted from or leased in Lease Sale 55. (Redrafted from BLM, 1980a, by Rogers, Golden & Halpern.)

tomfish. In addition, fish spawning and rearing areas may also be preserved through tract deletion. Commercial fishing impacts, particularly those associated with shore-based competition and gear damage or loss, and impacts on marine birds and marine mammals will also be reduced.

The Bureau of Land Management attached a number of stipulations to Sale 55 leases. These stipulations obligate lessees to observe certain guidelines pertaining to protecting cultural and archeological resources, providing an environmental training program for all personnel involved in exploration or development activities, following prescribed pipeline siting practices, and constructing subsea wellheads and pipelines so they do not interfere with trawling or bottomfishing operations.

Leasing Activity and Future Exploratory Activity

Lease Sale 55 was held in Anchorage on October 21, 1980. This sale was characterized by relatively low industry interest; bidders offered a total of $117.6 million for 37 of the 210 tracts offered for lease. Nine companies participated in the bidding.

Location of the bids indicated interest in an anticline, stretching nearly 30 miles (48 km) from northwest to southeast, with potential for hydrocarbons. This structure, about 12 miles (19 km) wide and 30 to 45 miles (48-72 km) offshore, drew $112.3 million of the $117.6 million in high bids. ARCO placed the highest bid of the sale, $20.5 million, on tract 150 within the structure. An ARCO spokesman said the company's interest stemmed from extensive seismic work that indicated the government's estimate of oil in the sale area could be too low (Pacific Oil World Annual, January 1981, p. 66).

The Bureau of Land Management subsequently rejected bids on tracts 152 and 131 as being too low. This action reduced the total of the high bids in the sale to $109,751,073. Table 2 shows the status of bids in Sale 55.

The lack of industry interest in Sale 55 tracts was generally attributed to low resource potential and lack of discoveries in the Sale 39 lease area. Eleven holes drilled on northern Gulf of Alaska acreage acquired during Sale 39 (1976) were found to be dry.

Leases acquired in Sale 55 lie in waters that are from 328 to 574 feet (100 - 175 m) deep. Semisubmersible drilling rigs, the type most appropriate for use in these depths, are in short supply. This shortage of available rigs, coupled with environmental and weather conditions, will influence the timing of exploration on these leases.

It is expected that leaseholders will generally explore the highest-value blocks on each structure first. Leaseholders with moderate-value blocks likely will delay exploration until early drilling results on the high-value blocks become known. For this reason, in a frontier OCS area such as the Gulf of Alaska, the intensity of exploration and interest in future lease sales are strongly influenced by results from the tracts first explored.

ARCO will probably take the lead in exploring Lease Sale 55 leases, but officials at ARCO have stated tentative plans to begin exploration in early 1982, rather than this summer (Knowles, 1981, oral commun.)

The proximity of Chevron's tract 174 to ARCO's tract 150 is a strong indication that the Chevron group may participate with ARCO in the exploratory drilling. As of May 1981, however, neither company has submitted an exploration plan to the USGS. (Refer to figure 8 for location of these tracts.)

FIRST REOFFERING SALE (RS-1)

In a news release issued on March 4, 1981, the Department of the Interior announced publication of a proposed notice of sale for a reoffering sale of offshore oil and gas leases in the northeastern Gulf of Alaska. This reoffering sale, RS-1, is tentatively set for late June 1981. The sale proposal includes 175 tracts, totaling about 996,306 acres (403,200 hectares). Two of the tracts to be

TABLE 2.—Lease Sale 55 bids

Bidder	Tract no.	Total bonus	Bidder	Tract no.	Total bonus
ARCO	101	$ 150,336	ARCO	176	$3,598,848
ARCO	102	300,672	ARCO	197	1,002,240
ARCO	103	300,672	ARCO	198	1,002,240
ARCO	104	502,134	Chevron and others	199	213,000
ARCO	105	300,672	Chevron and others	200	1,312,000
ARCO	127	180,403	ARCO	204	150,336
ARCO	128	6,981,120	Chevron and others	205	213,000
ARCO	129	10,164,000	ARCO	209	370,944
ARCO	130	9,501,696	ARCO	210	370,944
ARCO	131*	1,804,032	Chevron and others	222	213,000
ARCO	148	150,346	Chevron and others	223	712,000
ARCO	149	4,002,048	Shell	227	153,000
ARCO	150	20,507,904	Chevron and others	228	213,000
ARCO	151	12,121,256	Shell	229	153,000
ARCO	152*	5,995,008	Shell	232	541,000
ARCO	153	150,336	ARCO	233	2,511,360
ARCO	173	7,750,656	Shell	247	207,000
Chevron and others	174	11,424,000	Shell	248	353,000
ARCO	175	12,128,256			

*Bids rejected as insufficient.

SOURCE: Oil and Gas Journal, October 27, 1980.

reoffered, numbers 131 and 152, are near the anticline that received industry interest in Sale 55. These tracts attracted high bids from ARCO in Sale 55; however, the bids were rejected as insufficient. The other 173 tracts to be offered have never been bid upon.

The Department of the Interior notified Governor Jay Hammond of Alaska of the proposed sale and asked the Governor to respond with any comments or new information relative to the size, timing, or location of the proposed sale that might influence the Secretary of the Interior's final decision on the sale.

As discussed in the previous section on Lease Sale 55, the tracts offered in the northeastern Gulf of Alaska have gained relatively little industry interest thus far. The number and amount of bids received in Sale 55 indicates that industry considers the area to have a low potential for the production of hydrocarbons. Based on the outcome of Sale 55, the Department of the Interior expects "only very limited bidding interest" in the upcoming reoffering sale (BLM news release, 1981).

Secretary of the Interior James Watt had considered including in Sale RS-1 the 140 blocks deleted prior to Lease Sale 55, but these ecologically sensitive blocks will not be included.

The Office of OCS Information will monitor and will report on submission of exploration plans and expected rig activities in future Gulf of Alaska Summary Reports.

3. Oil and Gas Transportation Strategies

If commercially producible quantities of hydrocarbons are discovered as a result of future exploration of leases in the northeastern Gulf of Alaska, they will have to be transported for processing and refining. Crude oil can be transported from the production site either by pipelines or tankers. Natural gas can be piped to a refinery or to a liquefaction plant, and from there it can be piped onto special liquefied natural gas (LNG) vessels and shipped to other locations.

In view of these options, and because the process of planning for and constructing the necessary transportation facilities is complex and expensive, transportation strategies should be formulated as early as possible, preferably even before the lease sale is held.

OCS TRANSPORTATION PLANNING

Intergovernmental Planning Program

Many government agencies and private industries have roles to play in planning for and regulating oil and gas transportation. The Bureau of Land Management (BLM), through its Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities (IPP), takes the lead role in transportation planning.

The IPP was officially initiated on September 20, 1979, when the private-sector appointments were made to the Regional Technical Working Group (RTWG) Committees. These working group committees are composed of Federal and State officials and representatives of industry and other special and private interests. The members of the Alaska RTWG Committee, as of April 1, 1981, are listed in table 3.

The movement of oil and/or gas from the Outer Continental Shelf to processing points and to users is an important part of the overall RTWG planning function. The principal end product of this planning effort is a Regional Transportation Management Plan (RTMP). If commercially producible quantities of oil or natural gas are discovered in the Alaska leasing Region, an RTMP will be developed. At a minimum, the RTMP will include the following information and recommendations:

- analyses and recommendations for discrete transportation corridors and alternatives, including all routes to onshore facilities or to offshore terminals serving as collection points for more than one production area;
- identification of environmentally sound areas for the possible location of onshore facilities;
- alternatives regarding surface vessel transportation, in accordance with appropriate regulatory agencies;
- plans for monitoring construction and operations and any required follow-up studies; and
- any stipulations and use restrictions identified as applicable to transportation rights-of-way.

On December 4-5, 1980, an Alaska Region IPP meeting was held at the BLM office

TABLE 3.—Alaska Regional Technical Working Group Committee

Member	Affiliation
Capt. John C. Hansen	U.S. Coast Guard
Mr. Ron Morris	National Ocean & Atmospheric Administration, National Marine Fisheries Service
Mr. Gerald Reid	Fish and Wildlife Service
Mr. Rod Smith	U.S. Geological Survey
Mr. Jim Sweeney	Environmental Protection Agency
Ms. Esther Wunnicke	BLM Alaska OCS Office
Mr. Warren Sparks (acting)	State/Federal Transportation Planning Organization
Mr. Bill Van Dyke	State of Alaska
The Hon. Alan Beardsley	Mayor, City of Kodiak
(vacant)	League of Women Voters
Mr. Dave Benton	Friends of the Earth
Mr. Geron Bruce	United Fishermen of Alaska
Ms. Kay Diebels	Private citizen
Mr. Gil Jemmott	Alaska Oil & Gas Association
Mr. Caleb Pungowiyi	Kawerak, Inc.

For further information concerning the Alaska Regional Technical Working Group Committee membership, contact Gordy Euler, Bureau of Land Management, 620 East 10th Avenue, P. O. Box 1159, Anchorage, AK 99510 (telephone: (907) 276-2955).

in Anchorage. This meeting was convened in order for the members to discuss issues arising from Lease Sale 55. The Phase I Status Report for eastern Gulf of Alaska Sale 55, presented at the meeting, discusses the following:

- an identification of possible pipeline corridors, and an indication of the extent to which these were discussed in the environmental impact statement (EIS);
- a discussion of how planned regional studies will fill data gaps; and
- an indication of the criteria to be used to evaluate possible pipeline corridors.

Also dealt with in the Status Report are lease stipulations regarding transportation operations; physical and environmental constraints to oil and gas transportation; and additional considerations for corridor evaluations.

The following is a summary of topics discussed in the Phase I Status Report.

LEASE STIPULATIONS FOR TRANSPORTATION

Sale 55 lessees are bound by the following stipulations. Pipelines must be used (1) if pipeline rights-of-way can be determined and obtained; (2) if laying such pipelines is technically feasible and environmentally preferable; and (3) if, in the opinion of BLM, pipelines can be laid without net social loss, taking into account any incremental costs of pipelines over other methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts. All oil and gas pipelines are to be designed and constructed to provide adequate protection from water currents, storms, and geological or other hazards. In addition, subsea wellheads, temporary abandonments, or suspended operations that leave protrusions above the sea floor must be protected, if feasible, so as to allow commercial trawling gear to pass over the structure without snagging or otherwise damaging the structure or the fishing gear. Pipelines that are not buried must be smooth-surfaced, with no protrusions, to allow clear passage of the trawling gear over them. In addition to these lease stipulations, operators are bound by the U.S. Geological Survey's operating orders for the Gulf of Alaska.

PHYSICAL AND ENVIRONMENTAL CONSTRAINTS TO OIL AND GAS TRANSPORTATION

Several geologic and environmental factors would constrain the siting of submarine pipelines and pipeline landfalls if hydrocarbons

were produced from the northeastern Gulf of Alaska. A recent study, the product of the OCS Environmental Assessment Program (a National Oceanic and Atmospheric Administration program) study has delineated such sensitive areas.

Tracts leased in Sale 55 lie in the Yakutat district of the Gulf of Alaska Tertiary Province. This province is one of the most seismically active areas of the United States. The Yakutat district is in a zone where major damage may occur, with earthquakes ranging from 6.0 to 8.8 on the Richter scale.

Damage to offshore structures could be caused by a variety of quake-caused events, such as tsunamis (seismic sea waves), landslides, avalanches, mud flows, faulting (ground breaking), liquefaction of soils, differential compaction of soils, and seismically induced glacial-lake breakouts.

Areas of known or potential unstable bottom sediments, gas-charged sediments, and bedforms in or near the leased tracts are shown on figure 14 in appendix A. The effects of unstable bottom sediments on any proposed structures must be studied when submarine pipelines are sited.

Hazards such as gas-charged sediments and migrating bedforms may influence the location of offshore facilities. Shallow, gas-charged sediments, present in the leased area, may necessitate the careful use of appropriate drilling and pipeline trenching techniques. Bedforms in the northeastern Gulf, some of which may be as high as 33 feet (10 m) and 3,281 feet (1,000 m) long, could pose some geotechnical problems in offshore pipeline siting. For a more detailed discussion of geohazards, refer to appendix A.

FISHERIES

Pipelaying operations, as well as leakage of oil from pipes and tankers, present potential conflicts with fisheries and fish-spawning areas. The mounds created in the process of trenching pipelines could interfere with both trawling and bottomfishing. Chronic small leaks and spills from pipes or tankers are a source of pollution hazardous to delicate marine ecosystems.

The most sensitive tracts, in terms of fisheries, were deleted from Lease Sale 55. Since the areas of highest productivity are in shallower waters, 82 feet (25 m) or less, well-managed hydrocarbon exploration, development, and production activities would have few negative impacts on the nearshore environments.

OIL SPILL CONTINGENCY PLANNING AND CLEANUP TECHNOLOGIES

Planning for and responding to an oil spill involves a number of government agencies as well as the oil industry itself. In more developed OCS regions, planning and response activities and responsibilities are set out in formal documents. The prime responsibility for cleaning up an oil spill lies with the oil operator who caused the spill. The U.S. Geological Survey (USGS) OCS operating orders for the Gulf of Alaska require the leaseholders to submit an oil spill contingency plan for approval by the area supervisor, with or prior to submitting an exploration plan or a development and production plan. Oil spill contingency plans are reviewed annually. Should the originator of a spill be unknown, or if the spill exceeds the operator's capabilities, the U.S. Coast Guard's Regional Response Team, headed by an on-scene coordinator, will assemble the necessary government and private agencies and individuals for a quick response.

In a frontier area such as the Gulf of Alaska, the manner in which an oil spill would be managed is not well established, although preliminary work has been done. A Pollution Contingency Plan for Coastal Alaska has been formulated (U.S. Coast Guard, 1979), and baseline studies have been undertaken to determine, for example, which areas of the coast would be most vulnerable to a spill, which areas would recover most quickly, and what types of wind and wave action might interfere with cleanup operations. The USGS conducted an oil spill risk analysis (Lanfear

and others, 1979) to determine the relative environmental hazards of developing oil in different regions of the Lease Sale 55 area. The study analyzed the probability of spill occurrences, likely paths of spilled oil, and locations of resources vulnerable to spilled oil (refer to appendix D for details of this study).

The Bureau of Land Management published information related to oil spills in the Lease Sale 55 EIS. This data, along with more site-specific cataloging of coastal environments and habitats, can be found in a number of studies (see appendix D).

An oil spill contingency plan, a pilot project tailored to the coastline around Yakutat, was produced for the State of Alaska by Woodward-Clyde Associates in early 1981. Officials in Yakutat have found this plan inadequate for their needs, principally because the plan calls for a large number of "response team" members to be drawn from the community. With only 600 residents, many of whom live either outside the city limits or elsewhere part of the year, Yakutat could not assemble such a force.

4. Nature and Location of Nearshore and Onshore Facilities

The onshore effects of OCS activity in the Gulf of Alaska subregion to date have been associated with support bases for exploratory drilling on Sale 39 leases. The onshore activity resulting from Lease Sale 39 was concentrated in Yakutat and Seward. Support activity for Lease Sale 55 and Sale RS-1 activities will center in Yakutat (fig. 9). The general nature of support activity for exploratory drilling in the Gulf of Alaska is discussed in the first section of this chapter. Information concerning the community to be affected by Lease Sales 55 and RS-1 follows the first section.

SITING ONSHORE FACILITIES

Before offshore exploration can take place, some onshore activities and facilities must exist. The oil and gas operators and the independent support industries involved in offshore exploration, development, and production must acquire land for centralized bases. These onshore support bases are the service areas for offshore activities. After arriving at the support base, materials and personnel needed to support exploration are moved from the support base to offshore rigs either by supply boats or helicopters. The primary locational factors in siting a support base are the distance from offshore activity and the proximity to deepwater channels and land transportation routes. In this case, there is no land transportation route. Support bases are optimally located at shore points that are closest to the offshore operations sites.

In the event that offshore exploration leads to discovery of commercially producible hydrocarbons, sites near Yakutat may be selected for a deepwater port, a marine terminal, or a liquefied natural gas (LNG) plant.

While the convenience of the support base or any other facility for oil and gas operators is a major consideration in siting a support base, the wishes of the local community, the existing infrastructure, and environmental conditions also strongly influence facility siting.

STATE OF ALASKA'S POLICY

The State of Alaska, through the activities of its Coastal Management Policy Committee and its Governor, has developed specific policies for the management of nearshore and onshore effects of OCS oil and gas development. These policies, stated below in general terms, form one component of the general policy base for the Alaska Coastal Management Plan (Kramer and others, 1978). In the management of nearshore and onshore activities related to development of hydrocarbon resources off Alaska, the State's overall goal is to gain the maximum benefit with minimum cost to the State and its people. Achieving this goal involves accomplishing the following objectives:

- encouraging public involvement in the facility siting decisionmaking process;
- consolidating petroleum-related facilities;
- reusing or restoring developed areas;

FIGURE 9.—Yakutat, Alaska. (Photograph by Karen Collins, Rogers, Golden & Halpern.)

- protecting environmental quality;
- providing employment opportunities for Alaskans;
- promoting equitable sharing of public costs;
- employing temporary measures for short-term demands; and
- maintaining local management of OCS development impacts.

The manner in which the city of Yakutat met the challenges arising from exploration of nearby Sale 39 leases reflects these policies. In addition to minimizing any negative impacts of petroleum resource development on its small community, the city has, over the past few years, developed a good working relationship with oil industry representatives. The representatives have made clear their intentions to conduct future onshore operations in Yakutat in the same manner as their earlier exploration efforts (Knowles, 1981, oral commun., and Kohler, 1981, oral commun.). At that time, non-local workers were brought directly to the Yakutat airport; from there, they were flown by helicopter to the offshore rig. This method of segregating oil- and gas-related activity from the everyday life of a community is called the **enclave** approach.

ENCLAVE SETTLEMENTS

The residents of Yakutat believe that the exploration, development, and production of oil and gas off their shores will significantly increase their population through an influx of industry-related employees. In their opinion, this increase will have a deleterious effect on their subsistence fishing (fig. 10) and hunting, and it will have negative impacts on their long-established native culture. These concerns were reflected in documents prepared chiefly in response to Lease Sale 39: the Yakutat Comprehensive Development Plan (Alaska Consultants, 1976), the City of Yakutat Capital Improvements and Services Program (Alaska Consultants, 1978), and the Yakutat District Coastal Management Plan-Review Draft (Alaska Consultants, 1980).

The State of Alaska, the City of Yakutat, the Yak-Tat Kwaan, Inc., and the Yakutat Village Native Corporation effec-

FIGURE 10.—Commercial and private fishing boats in Shipyard Cove, Yakutat, Alaska. (Photograph by Anne Stadnychenko, Rogers, Golden & Halpern.)

tively control the available land in the Yakutat area--either by direct ownership or zoning powers. It is the stated intention of these groups to require the oil companies using Yakutat as a base for offshore operations to construct and maintain employee enclaves apart from the native community (Powell, 1981, oral commun.).

A rigorously enforced enclave, an industrial compound physically and socially separated from a community, would theoretically have little impact on that community's lifestyle. Officials in Yakutat, however, are doubtful about the practicability of the enclave concept. The Lease Sale 55 EIS did not set out in detail how the enclave would be established or how it would operate as a totally discrete, self-supporting social unit. Studies elaborating on the enclave theme are currently ongoing under the auspices of the BLM's Socioeconomic Studies Program (see appendix D for details).

SUPPORT BASES

In general, support bases for exploratory drilling include the following:

- warehouse and open storage areas,
- dock space for berthing, loading, and unloading supply boats,
- a helicopter landing pad (helipad),
- office and parking space for supervisory and communications personnel, and

- repair service for rigs and supply boats.

Support bases generally range in area from 2-1/2 acres (1 hectare) up to 25 acres (10 hectares).

In conjunction with Lease Sale 39 (1976) activities, the Atlantic Richfield Company (ARCO), in partnership with Shell Oil Company, acquired 2-1/2 acres (1 hectare) of land on the south side of Monti Bay, across from the city of Yakutat, and constructed a small support base (fig. 11). This base consists of a finger pier 115 feet (35 m) long and 24 feet (7.3 m) wide, with both covered and open storage space. In addition, the ARCO/Shell consortium leased from the Yak-Tat Kwaan (a native corporation) an adjacent 77-acre (31-hectare) parcel for possible expansion of onshore service operations. Officials at ARCO intend to use this established base as a service base for future exploration of leases purchased in Sale 55 (Knowles, 1981, oral commun.).

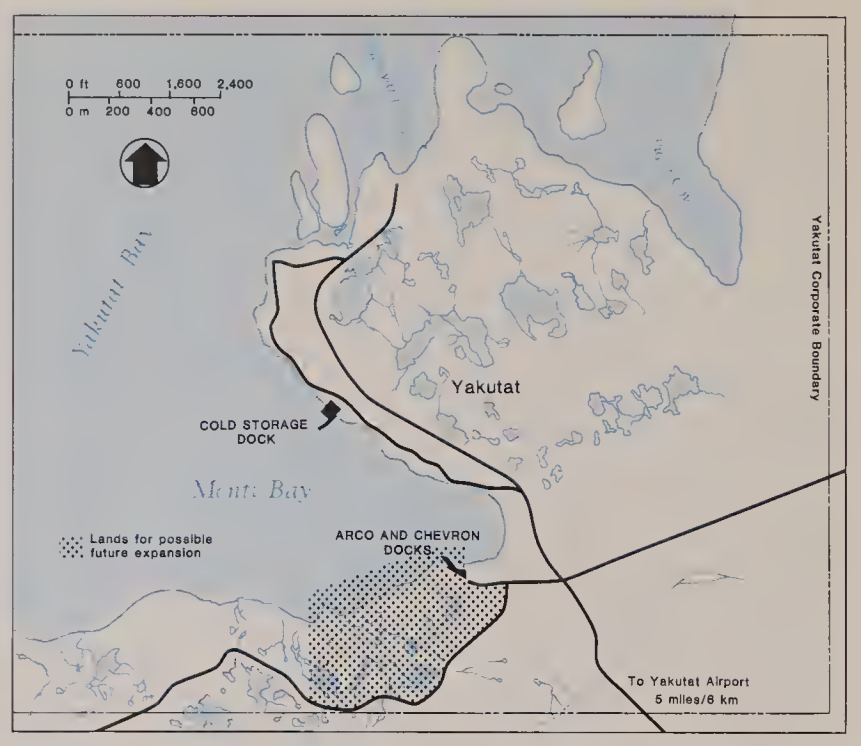


FIGURE 11.—Existing OCS facilities at Yakutat, and lands for possible future expansion. (Adapted from Jackson and Dorrier, 1980, by Rogers, Golden & Halpern.)

MARINE TERMINAL

Yakutat Bay is the only large, protected, natural deepwater port on the Gulf of Alaska coast between Cordova and Cape Spencer (fig. 12). As such, it is the most likely site for a marine terminal serving potential oil and gas producers in the northeastern Gulf area.

If significant quantities of hydrocarbons are produced from the Gulf, it should be cost-effective for the operators to build a pipeline to shore; at the marine terminal, crude could be loaded onto tankers and shipped out of the area. Commercial quantities of natural gas could be piped to shore to be liquefied and then transshipped. It would not be feasible, in any event, for operators to construct an extensive onshore crude or natural gas pipeline system. Existing pipeline networks are too far away for economical connection with coastal pipelines on the Gulf of Alaska.

LNG PLANT

The Yak-Tat Kwaan previously leased a 400-acre (161.9-hectare) parcel of land adjacent to the ARCO/Shell supply dock to the Pacific Alaska LNG Company. This company had planned to construct a gas liquefaction plant on 30 percent of the site, but it lost interest in the project when the disappointing results of drilling on Sale 39 leases became known.

Although a spokesman at ARCO recently identified potential industry interest in the Redfield Cove area as a site for an LNG plant or a marine terminal, this representative also stated that ARCO has no current plans to initiate or participate in either project (Knowles, 1981, oral commun.). As stated earlier, ARCO will most likely take the lead in exploration of Sale 55 leases, allowing other leaseholders to base their future plans on ARCO's successes or failures. Without knowing if commercial quantities of hydrocarbons

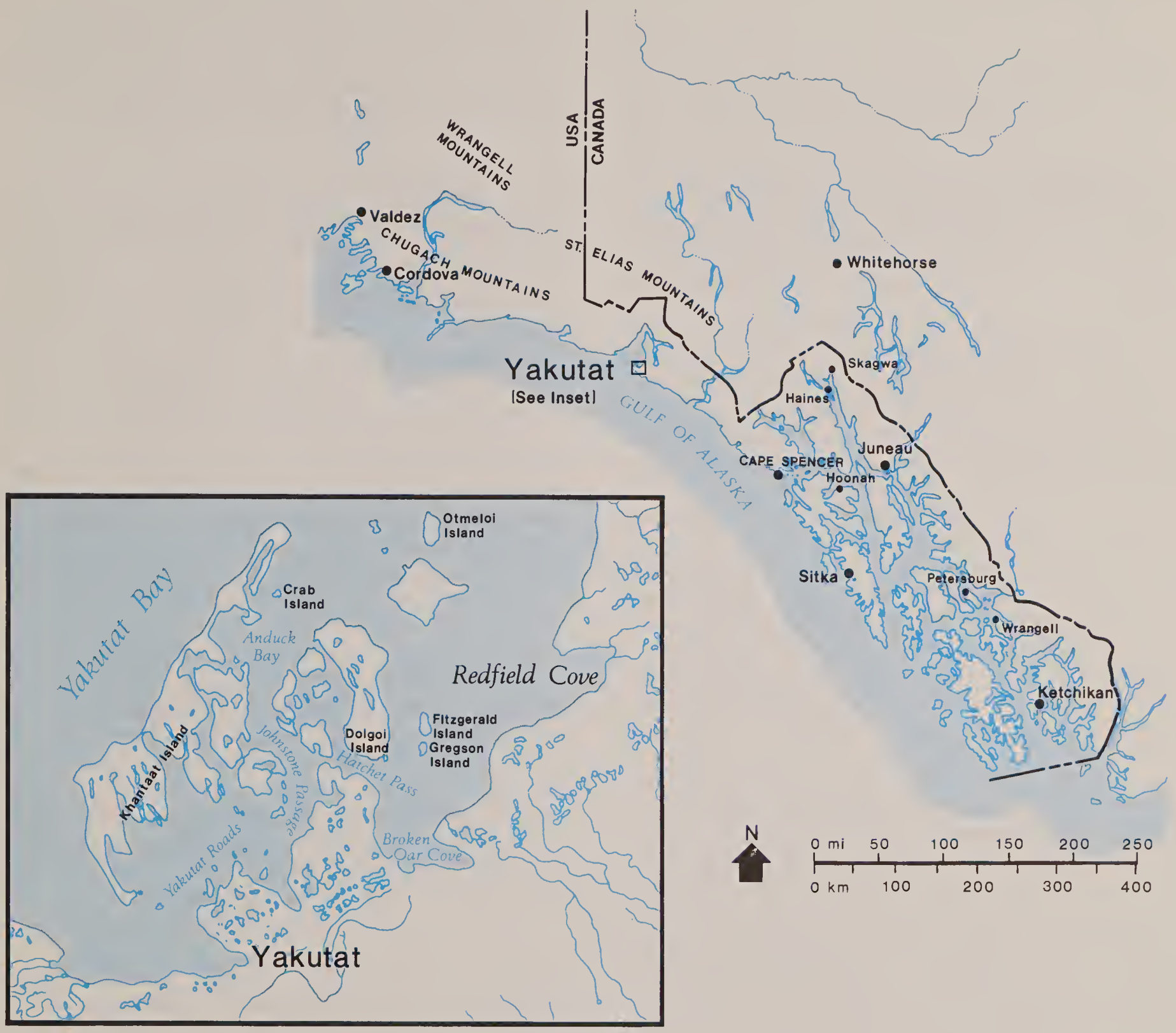


FIGURE 12.—Southern Alaska, Yakutat Bay, and potential LNG site (Redfield Cove). (Adapted from Alaska Consultants, Inc., 1980, by Rogers, Golden & Halpern.)

can be produced from the northeastern Gulf of Alaska, industry probably will not construct either a marine terminal or an LNG plant in the immediate future.

CONCLUSION

Although no commercial quantities of hydrocarbons have been discovered so far in the Gulf of Alaska, a study of this area in terms of the potential effects of oil and gas exploration, development, and production is useful.

The Gulf of Alaska is a unique area. It is extremely rich in natural beauty and resources--highly valuable wetlands, fisheries, and rookeries--and a proud cultural heritage. In this frontier oil and gas region, the relatively short-term rewards of hydrocarbon production must be carefully balanced against potentially deleterious effects on delicate natural and social systems that predate the "oil age" by hundreds of years and that Alaskans hope, will endure for generations to come. Perhaps more in the Gulf of Alaska than in any other OCS area, careful decisions must be made regarding the management of OCS-related developments onshore.

The Yakutat experience with Lease Sale 39 events showed that organized small communities can greatly influence the role they play in petroleum resource development. When a constant, clear dialogue exists among all parties involved in the OCS process (the Federal Government, the State, the local community, and industry), it is possible for all interests to be served through compromise.

Formal mechanisms exist for establishing such a dialogue. In 1975, the Department of the Interior instituted a consultation process that allows various agencies within the Department to obtain a consensus on specific lease stipulations and notice to lessee requirements for each lease sale. These meetings have been expanded to include agencies of other potentially affected departments.

As a result of the Council on Environmental Quality's regulations for implementing the procedural provisions of the National Environmental Policy Act (Federal Register, November 29, 1978), the Bureau of Land Management (BLM) has instituted a scoping process: a series of public meetings to determine issues of concern, possible alternatives, and possible mitigating measures. These meetings are open to Federal and State agencies, special interest groups, and citizens. They are held for each lease sale after tract selection and prior to the time that the BLM prepares a draft EIS. The concerns voiced in these meetings are incorporated into the EIS and are used to focus it. Scoping meetings for Lease Sale 55 were held in Anchorage and Yakutat.

The Office of OCS Information offers additional help in planning for coastal effects associated with OCS oil and gas development through a program of limited technical assistance. All requests for technical assistance will be evaluated and approved on a case-by-case basis, and inquiries should be directed to the OCSI Office at the address shown in the inside front cover of this publication.

References

Alaska Consultants, Inc., 1976, Yakutat Comprehensive Development Plan, Anchorage, 228 p.

-----, 1978, City of Yakutat Capital Improvements and Services Program, Anchorage.

-----, 1980, Yakutat District Coastal Management Plan Review Draft, Anchorage.

Barry, Mary J., 1973, A history of mining on the Kenai Peninsula: Anchorage, Northwest Publishing Company, 214 p.

Benton, J., McDowell, T., and Conner, W., 1979, Alaska Index (December 1974-June 1979): Washington, D.C., prepared for the U.S. Geological Survey by the MITRE Corporation, U.S. Geological Survey Open-File Report 79-1345, 91 p.

Bird, Cyril, 1980, Estimated oil and gas reserves, Southern California Outer Continental Shelf, January 1, 1979: Draft U.S. Geological Survey Open-File Report.

Bureau of Land Management, 1976, Final environmental impact statement: proposed OCS oil and gas lease sale, Northern Gulf of Alaska OCS Sale No. 39: Anchorage (Alaska OCS Office), 4 vols.

-----, 1980a, Final environmental impact statement: proposed OCS lease sale, Eastern Gulf of Alaska, Sale No. 55: Anchorage (Alaska OCS Office), 2 vols.

-----, 1980b, Draft environmental impact statement: proposed OCS oil and gas Lease Sale No. 60: Anchorage (Alaska OCS Office).

-----, 1980c, Final environmental impact statement: proposed 5-year OCS oil and gas lease sale schedule, March 1980 - February 1985: Washington, D.C.

-----, 1980d, Intergovernmental Planning Program--Alaska Regional Technical Working Group: Phase I Status Report, Eastern Gulf of Alaska Sale 55: Anchorage.

-----, 1981, March 4 news release, Proposed Notice of Sale issued for first OCS reoffering sale, Washington, D.C.

Davies, John Dr., 1981, Research Associate for Lamont Doherty Geological Observatory of Columbia University, Palisades, NY, oral communication.

Dolton, G.L., and others, 1981, Estimates of undiscovered recoverable resources of conventionally producible oil and gas in the United States--a summary: U.S. Geological Survey Open-File Report 81-192, 17 p.

Dorrier, Richard T., 1981, Alaska Index (December 1974-November 1980): prepared for the U.S. Geological Survey by Rogers, Golden & Halpern, U.S. Geological Survey Open-File Report 81-20, 85 p.

Federal Register, 1978, v. 43, p. 55977-56007, November 29.

Gates, G.O., Grantz, A., and Patten, W.W., 1968, Geology and natural gas and oil reserves of Alaska, **in** Beebe, D.W., and Curtis, B.F., eds., Natural gases of North America: American Association of Petroleum Geologists Memoir 2, v. 1.

Gryc, George, 1971, Summary of potential petroleum resources in Region 1 (Alaska and Hawaii)--Alaska, **in** Cram, Ira H.,

ed., Future petroleum provinces of the U.S.--their geology and potential: American Association of Petroleum Geologists Memoir 15, v. 1, 12 p.

Jackson, Joanne B., 1980, Outer Continental Shelf oil and gas activities in the South Atlantic (U.S.) and their onshore impacts: a summary report: prepared for the U.S. Geological Survey by Rogers, Golden & Halpern, July 1980, U.S. Geological Survey Open-File Report 80-626, 59 p. and appendixes.

Jackson, Joanne B., and Dorrier, Richard T., 1980, Outer Continental Shelf oil and gas activities in the Gulf of Alaska (including Lower Cook Inlet) and their onshore inpacts: a summary report: prepared for U.S. Geological Survey by Rogers, Golden & Halpern, September 1980, U.S. Geological Survey Open-File Report 80-1028.

Jones, Joe M., 1980, Resource estimates for leased OCS tracts in Lower Cook Inlet and Northern Gulf of Alaska: U.S. Geological Survey, Conservation Division, Alaska Region, memorandum, June.

Knowles, Richard, 1981, Drilling Supervisor for Alaska, Atlantic Richfield Company, oral communication.

Kohler, Jim, 1981, City Manager, City of Yakutat, oral communication.

Kramer, L., and others, 1978, Alaska Coastal Management Plan.

Lahr, J.C., and Plafker, George, 1980, Holocene Pacific--North American Plate interaction in Southern Alaska: implications for the Yakataga seismic gap: Geology, v. 8, October, p. 486.

Lahr, J.C., Plafker, G., Stephen, C.D., Fogleman, K.A., and Blackford, M.E., 1979, Interim report on the St. Elias earthquake of 28 February 1979: U.S. Geological Survey Open-File Report 79-670.

Lahr, J.C., Stephens, C.D., Hasegowa, H.A., and Boatwright, J., 1980, Alaskan seismic gap only partially filled by 28 February 1979 earthquake: Science, v. 207, March.

Lanfear, Kenneth J., Nakassis, Anastasis, Samuels, William B., and Schoen, Christina T., 1979, An oil spill risk analysis for the northern Gulf of Alaska (Proposed Sale 55) Outer Continental Shelf Lease Area, U.S. Geological Survey Open-File Report 79-1284, 44 p. and appendixes.

Lowry, Paul, 1981, Physical Scientist, U.S. Geological Survey, Conservation Division, Anchorage, oral communication.

Lynch, Maurice B., 1981, Geologist, U.S. Geological Survey, Conservation Division, Anchorage, Alaska, memorandum to Paul Lowry, Physical Scientist, U.S. Geological Survey, Conservation Division, March 4.

McCann, W.R., Perez, O.J., Sykes, L.R., 1980, Yakataga Gap, Alaska: Seismic history and earthquake potential: Science, v. 207, March 1980.

Miller, B.M., and others. 1975, Geological estimates of undiscovered recoverable oil and gas resources in the U.S.: U.S. Geological Survey Circular 725, 78 p.

National Oceanic and Atmospheric Administration, 1980, Technical Development Plans, FY 81 Gulf of Alaska, Environmental Assessment of the Alaska Continental Shelf, August 15.

Oil and Gas Journal, 1980, v. 78, no. 43, October 27.

Pacific Oil World Annual, 1981, January.

Plafker, George, 1971, Possible future petroleum resources of Pacific-Margin Tertiary Basin, Alaska, **in** Cram, Ira H., ed., Future petroleum provinces of the U.S.--their geology and potential: American Association of Petroleum Geologists Memoir 15, v. 1.

Plafker, George, Bruns, T.R., and Page, R.A., 1975, Interim report on petroleum resources potential and geologic hazards in

the Outer Continental Shelf of the Gulf of Alaska Tertiary Province: U.S. Geological Survey Open-File Report 75-592.

Plafker, George, Bruns, T.R., Carlson, P.R., Molnia, B.F., and others, 1978, Petroleum potential, geological hazards, and technology for exploration in the Outer Continental Shelf of the Gulf of Alaska Tertiary Province: U.S. Geological Survey Open-File Report 78-490.

Plafker, George, Winkler, G.R., Conrad, W.L., and Claypool, G., 1980, Preliminary report on the geology of the Continental Slope adjacent to OCS Lease Sale 55, Eastern Gulf of Alaska: Petroleum resource implications: U.S. Geological Survey Open-File Report 80-1089.

Powell, Larry, 1981, Mayor, City of Yakutat, oral communication.

Stephens, C.D., Lahr, J.C., Kent, A.F., and Horner, R.B., 1980, The St. Elias, Alaska, Earthquake of February 28, 1979: regional recording of aftershocks and short-term pre-earthquake seismicity: Bulletin of the Seismological Society of America, v. 70, no. 5, p. 1607-1633, October.

Tissot, B.P., and Welte, D.H., 1978, Petroleum formation and occurrence: New York, Springer-Verlag, 538 p.

Turner, Bruce W., Thrasher, Glenn P., and Molnia, Bruce F., 1980, Joint Conservation Division and Geologic Division meeting on the environmental geology of Eastern Gulf of Alaska, oil and gas Lease Sale Area 55: U.S. Geological Survey, Conservation Division, Alaska Region, memorandum, April.

U.S. Coast Guard, 1979, Alaska Coastal Region, Multi-agency oil and hazardous substances pollution contingency plan; Juneau.

U.S. Geological Survey, 1980, Gulf of Alaska Outer Continental Shelf Orders Governing Oil and Gas Lease Operations.

-----, 1981, Final Outer Continental Shelf Orders Governing Oil and Gas Lease Operations in the Arctic.

Von Huene, Roland, Lathram, E.H., and Reimnitz, E., 1971, Possible petroleum resources of offshore Pacific-Margin Tertiary basin, Alaska, in Cram, Ira H., ed., Future petroleum provinces of the U.S.--their geology and potential: American Association of Petroleum Geologists Memoir 15, v. 1, 15 p.

Wills, John, 1981, U.S. Geological Survey, Conservation Division, Anchorage, oral communication.

-----, 1981, U.S. Geological Survey, Conservation Division, Anchorage, Cross section for Lease Sale 55 area in the Eastern Gulf at Alaska: scale 1:750,000.

Appendix A. The Geologic Setting

PETROLEUM GEOLOGY

Hydrocarbons are formed within the upper part of the earth's crust, where accumulations of organic matter are transformed through the action of heat and pressure into various mixtures of crude oil and natural gas. The time between deposition of organic material and the formation of hydrocarbons is on the order of millions of years (Tissot and Welte, 1978, p. 198).

The occurrence of hydrocarbon accumulation depends on many factors (Miller and others, 1975, p. 17):

- an adequate thickness of sedimentary rocks;
- the presence of source beds (rocks containing large amounts of organic matter);
- a suitable environment for maturation of the organic matter into oil and/or gas;
- the presence of porous and permeable reservoir rocks;
- hydrodynamic conditions permitting the migration of hydrocarbons and their ultimate entrapment in reservoir rocks;
- a thermal history that favors production and preservation of hydrocarbons;
- formation of adequate geologic traps for accumulation of the hydrocarbons; and
- suitable timing of petroleum generation and migration to ensure the entrapment and preservation of the hydrocarbons.

In a prospective hydrocarbon province, geologists look for structural or stratigraphic traps, in which oil and gas can accumulate. Structural traps include anticlines, sediments draped over salt diapirs and other dome-like intrusions, and fault traps. Examples of stratigraphic traps are reefs and the edges of porous strata truncated by impermeable strata. Traps may also be formed by a combination of structural and stratigraphic elements.

THE NORTHERN GULF OF ALASKA OUTER CONTINENTAL SHELF

The Lease Sale 55 area is located in the Gulf of Alaska Tertiary Basin of the northern Gulf of Alaska. This basin is 500 miles (900 km) long by 125 miles (200 km) wide. Approximately 20,000 square miles (52,000 km2) of the Gulf of Alaska Tertiary Basin lie offshore, where the province extends between Cross Sound and the Amatuli Trough. Petroleum seepages and petroliferous rocks occur onshore in the basin, and gas-charged sediments occur offshore.

The Tertiary rocks are known from onshore outcrops, geophysical investigation, and oil and gas wells drilled along the coastal lowland of the Gulf of Alaska (Plafker, 1971). Surface mapping of onshore areas has also been conducted since 1944 as part of the USGS's program of petroleum investigations in southern Alaska. More recently, seismic data

were collected for offshore areas overlying ocean-bottom dredging sites sampled between 1977 and 1979 by U. S. Geological Survey (USGS) research vessels along the 155-mile (250-km) northwest-trending Continental Slope between longitude 138 deg 00 min W. and 142 deg 30 min W. Outcrop samples were collected in water depths between 10,332 feet (3,150 m) and 656 feet (200 m) (Plafker, 1980) at the seaward margin of the northeastern Gulf of Alaska. The rock sequence sampled from the Continental Slope that extends beneath the Lease Sale 55 area is part of a relatively small triangular coastal plate informally named the Yakutat Block. Ocean-bottom dredging has been the most recent applicable method of stratigraphic testing for this segment of the northeastern Gulf of Alaska. To date, there has been no Continental Offshore Stratigraphic Test (COST) well drilling for the Lease Sale 55 area. Applications for permit to drill (APD's) have not yet been submitted to the USGS by any participating oil companies and actual exploratory drilling by the oil industry will probably begin no sooner than early 1982. The drilling delay results mainly from difficulties in obtaining an available semi-submersible rig suitable for rough Alaska waters (Knowles, 1981, oral commun.).

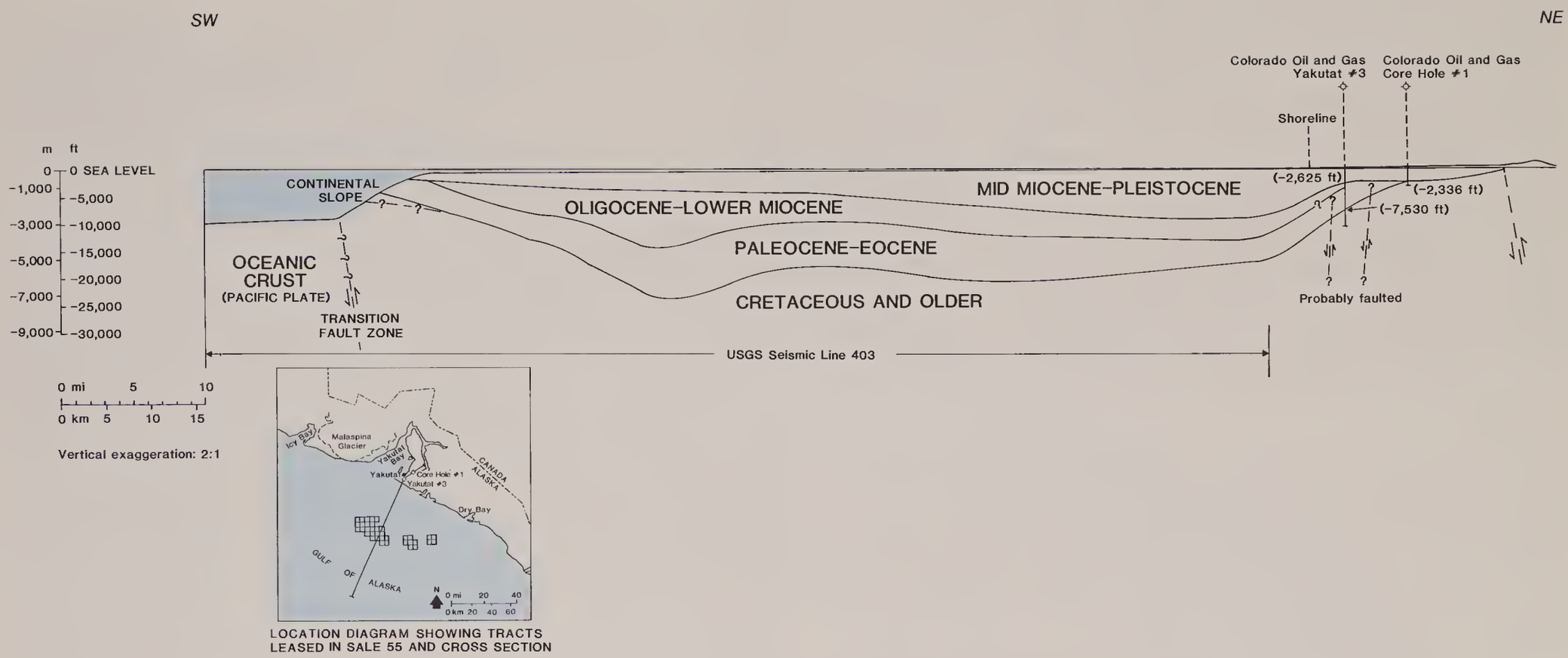
The Gulf of Alaska Tertiary Basin contains a thick sequence of sediments deposited during the Tertiary period, between 70 and 7 million years ago. These sedimentary rocks with petroleum reservoir potential have an approximate aggregate thickness of at least 40,000 feet (12,192 m) in the basin. The rocks with the greater petroleum potential were deposited during the middle and late Tertiary periods, and they have an average thickness of 10,000 to 21,600 feet (3,048 - 6,584 m) (Jackson and Dorrier, 1980).

Figure 13 provides a cross section of the basic geology of the northern Gulf of Alaska. As seen on the accompanying location map, the cross section cuts through the Lease Sale 55 area. The Tertiary rocks on the OCS comprise a wedge that dips and thins toward the coast. They are underlain by bedded rocks of Cretaceous and older periods. The older rocks are highly deformed and locally metamorphosed, with no potential for producing petroleum (Plafker, 1971).

Seven rock units of pre-Quaternary age have been tentatively delineated on the Continental Slope and adjacent Shelf in the Yakutat Block. Of these, four rock units with organic carbon content high enough to be considered potential source rocks for hydrocarbons have been recovered from the early Tertiary sequence. Argillaceous rocks (rocks having a clay composition) were found exposed on the lower part of the Continental Slope that show a degree of thermal maturity. This suggests that the rocks were probably buried to a depth of at least 9,800 feet (3,000 m) at some time (Plafker, 1980). The hydrocarbon potential of the source rocks was evaluated by analyses of total organic carbon content and by visual kerogen assessment.

The structural configuration of the Gulf of Alaska Tertiary Basin is mainly the result of interaction between the North American continent and the Pacific Ocean basin during the late Cenozoic era (Plafker, Bruns, and Page, 1975). Offshore parts of the Yakutat Block are characterized by an asymmetric, deep shelf basin containing middle (?) and late Cenozoic sedimentary rocks, and a general absence of compressional deformation in the post-Paleocene Cenozoic section. These features suggest that the Yakutat Continental Slope has been a trailing or strike slip margin --rather than a zone of convergence-- throughout much of the Cenozoic (Plafker, 1980). In this respect, the Continental Shelf and Slope of the Yakutat Block differ strikingly from those of the Yakataga area where Lease Sale 39 occurred. The Yakataga area of the province was in a zone of compression and shear due to apparent underthrusting of the Continental Margin. Exploration subsequent to Lease Sale 39 focused on larger, more continuous folds. Anticlines were northeast-southwest trending structures, ranging from 2-1/2 to 6 miles (4 -10 km) wide. Exploratory drilling failed to reveal any commercial deposits of hydrocarbons within the structures.

Hydrocarbon traps in the early Tertiary sequence in the Yakutat Block are likely to be more subtle. However, USGS seismic data indicate that a potential stratigraphic trap is detectable, trending northeastward beneath the Lease Sale 55 area from the west side of Fairweather Ground (Wills, 1981, oral commun.). Four tracts located in this area



LOCATION DIAGRAM SHOWING TRACTS LEASED IN SALE 55 AND CROSS SECTION

FIGURE 13.—Interpretive cross-section of northern Gulf of Alaska through the Lease Sale 55 area. (Adapted from Wills, 1981, by Rogers, Golden & Halpern.)

drew interest from ARCO and Shell Oil Company during the October 1980 lease sale (Sale 55). Seven tracts on the western side of the Sale 55 area, however, received the highest bids during the sale from ARCO and Chevron. Geologic information on these active leases is proprietary and is not included in this report. The critical factor for accumulation of hydrocarbons in commercial quantities here probably will be the occurrence of adequate traps at drillable depths.

Seismic history of the northern Gulf of Alaska indicates that this part of the Gulf of Alaska Tertiary Basin continues to experience disturbances. Large-scale faulting and ground movement occurred during the more recent major earthquakes in the region. During the 1964 Prince William Sound earthquake, severe ground cracking and differential subsidence affected the entire Gulf of Alaska coast as far east as Yakutat Bay (BLM, 1976). Tsunamis (seismic sea waves created by seabed displacement) have proven to be hazards in the event of a severe earthquake.

Large submarine sediment slides and slumps occur on the Continental Shelf and Slope of the Gulf of Alaska Tertiary Basin. Possibly seismically induced, the offshore slumping may cause landslides and other hazardous forms of mass movement. Several areas of unstable bottom sediments near the Lease Sale 55 area are shown in figure 14. These areas just offshore from Yakutat Bay, the Dangerous River outlet and Dry Bay, are covered by Holocene sediment that has undergone mass movement. Some segments contain a variety of features that may also be related to gas in sediment. Evidence of slumping includes disrupted sub-bottom reflectors, head scarps, hummocky downslope topography, and toes. In addition, high regional seismicity in the area increases the likelihood of soil failure (Turner and others, 1981). Any pipeline or facility siting study done on these areas should describe in detail the possible effects of such slumps on any proposed offshore activity.

Other types of geologic hazards that should be considered in the Gulf of Alaska OCS in the siting of structures include the following: (1) rapid marine sedimentation; (2) occurrence of submarine glacial moraines and buried ice; (3) high rates of local beach erosion and deposition; and (4) onshore glacial-lake breakout and landslide-generated waves in bays (Plafker and others, 1978).

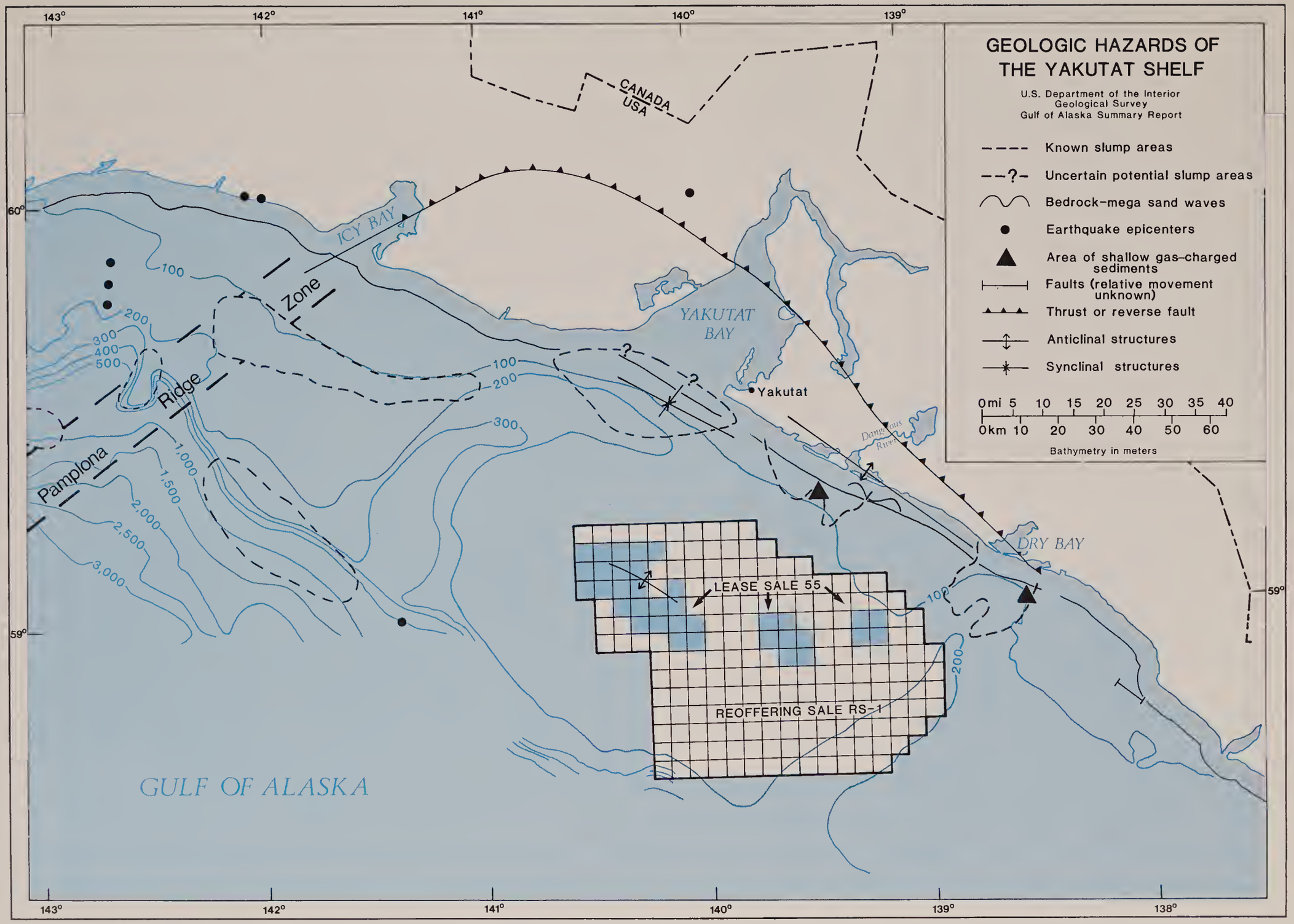


FIGURE 14.—Geologic hazards of the Yakutat Shelf. (Adapted from BLM, 1980d, by Rogers, Golden & Halpern.)

Appendix B. Estimating Oil and Gas Resources

Before exploratory drilling, both the Federal Government and industry undertake analyses of geological basins to determine their oil and gas potential. The Government uses a variety of methods of analysis, depending on the purpose of the estimate and the availability and level of detail of the data. The data base for resource estimation is regularly updated with new geologic and geophysical information, and as more data for a given area are gathered, processed, analyzed, and interpreted, the resource estimate is updated to reflect them.

Appendix B (p. 51-52) of the initial summary report for this region provided an in-depth presentation on estimating oil and gas resources, with emphasis on regionwide resource estimates, tract-specific resource estimates, and reserve estimates.

Appendix C. Intergovernmental Planning Program of the Bureau of Land Management

The Intergovernmental Planning Program (IPP) for OCS Oil and Gas Leasing, Transportation and Related Facilities was implemented to provide a formal coordination and a long-range planning mechanism for three major national OCS program elements administered by the Bureau of Land Management (BLM). These interdependent elements are Pre-Lease-Sale Activities, the Environmental Studies Program, and Transportation Planning: each is treated as a separate component of the IPP planning process. Transportation planning is discussed in chapter 3 of this report. The organization of the IPP and the other two elements--Pre-Lease-Sale Activities and the Environmental Studies Program--are presented in the initial Alaska Summary Report appendix (p. 53-62). That appendix concludes with a discussion of the four phases of BLM's IPP and of how the three elements of the OCS program and the four phases of the IPP are integrated for a given lease sale.

The first six meetings of the Alaska Regional Technical Working Group (RTWG) were discussed in detail in appendix C of the initial summary report. Four of these meetings were held in Anchorage, one in Juneau, and one in Norfolk, Virginia. After an initial introductory meeting, the RTWG presented environmental portrayals for proposed Lease Sales 57, 70, and 60 in their second, third, and fourth meetings. During the fifth meeting, the group reviewed proposed lease stipulations for Lease Sale 55. At the sixth meeting of the Alaska RTWG, the group adopted recommendations on the FY 1981 and FY 1982 Regional Studies Plans and identified issues for consideration in the environmental impact statement for proposed Lease Sale 71.

The most recent meeting was held in Anchorage on December 4 and 5, 1980. This meeting was convened in order to discuss issues surrounding Lease Sale 55. At this time, the Phase I Status Report for Lease Sale 55 was presented.

The current membership of the Alaska RTWG is given in table 3 (p. 20) of this report.

Appendix D. OCS-Related Studies

FEDERAL STUDIES

U.S. Department of the Interior:

Bureau of Land Management

The Bureau of Land Management (BLM) of the U.S. Department of the Interior conducts an Environmental Studies Program. The BLM Alaska OCS Office administers studies approved by the BLM Washington Office for the Alaska Region. Appendix C of the Gulf of Alaska Summary Report describes this program. Several studies have already been completed for Alaska, and additional studies are planned for fiscal year 1982. Some of the studies were conducted by other agencies within the Department of the Interior as a part of the BLM's Environmental Studies Program. The studies listed below were not included in the first Gulf of Alaska Summary Report. Completed studies may be reviewed at the Alaska OCS Office of the Bureau of Land Management, 620 East 10th Avenue, Anchorage, Alaska, or at the Washington OCS Office of the Bureau of Land Management, 18th and C Streets, NW, Washington, D.C.

Alaska Consultants, Inc., 1979, Western Gulf of Alaska petroleum development scenarios and local socioeconomic impacts: prepared for the Alaska OCS Office Socioeconomic Studies Program, Bureau of Land Management, Technical Report no. 40, 204 p. and appendix. Limited distribution through BLM Alaska OCS Office.

This report analyzes potential growth and community infrastructure impacts in Seward and Kodiak as a consequence of proposed western Gulf of Alaska OCS Lease Sale 46. The scenario method constructs and compares four different growth cases, including a base case without the lease sale and three distinct petroleum development cases.

Dames and Moore, 1979, Lower Cook Inlet and Shelikof Strait OCS Sale No. 60 petroleum development scenarios: prepared for the Alaska OCS Office Socioeconomic Studies Program, Bureau of Land Management, Technical Reports no. 43, 130 p. and appendixes, and no. 43a (Executive Summary), 33 p. Limited distribution through BLM Alaska OCS Office.

This report describes in detail a set of petroleum scenarios that are economically and technically feasible, based upon available estimates of oil and gas resources of the Lower Cook Inlet and Shelikof Strait, in order to analyze their socioeconomic and environmental impacts. The formulated scenarios are for the proposed OCS Lease Sale 60 and are intended to describe the incremental facilities, employment, and other impacts resulting from the sale. Scenarios included are exploration only, high find, and medium find.

Davis, Nancy Yaw, 1979, Western Gulf of Alaska petroleum development scenarios: Kodiak native sociocultural impacts: prepared by Cultural Dynamics for Alaska OCS Office Socioeconomic Studies Program, Bureau of Land Management, Technical Report no. 41, 272 p. Limited distribution through BLM Alaska OCS Office.

This report is intended to assist government and private planners and decisionmakers. The report is organized

in four major sections: (1) a discussion of methodology, (2) baseline information concerning native populations and contemporary issues, (3) a projected hypothetical future without OCS exploration or development, and (4) the hypothetical impacts of future OCS development in the western Gulf area on the native populations of Kodiak Island.

Huskey, Lee, and Nebesky, William, 1979, Western Gulf of Alaska petroleum development scenarios: economic and demographic impacts: prepared by the Institute of Social and Economic Research, University of Alaska, for the Alaska OCS Socioeconomic Studies Program, Bureau of Land Management, Technical Report no. 38, 381 p. Limited distribution through BLM Alaska OCS Office.

This study consists of three major parts: (1) a baseline study of the economies of the State and its Gulf of Alaska region, (2) a base case projection describing the future economy without western Gulf OCS petroleum development, and (3) an examination of the impact of western Gulf OCS petroleum development.

Lanfear, Kenneth, J., Nakassis, Anastasis, Samuels, William B., and Schoen, Christina, T., 1979, An oil spill risk analysis for the northern Gulf of Alaska (Proposed Sale 55) Outer Continental Shelf Lease Area: U.S. Geological Survey Open-File Report 79-1284, 44 p. and appendixes. Available from Open-File Services Section, USGS, Box 25425, Federal Center, Denver, CO 80225.

The U.S. Geological Survey's oil spill risk analysis determining the relative environmental hazards of developing oil in different regions of the Lease Sale 55 area is presented. The study analyzes the probability of spill occurrences, likely paths of spilled oil, and locations of resources vulnerable to spilled oil. The combined results yield estimates of the overall oil risks associated with development of the proposed lease area. The analysis includes estimates of weathering rates and oil slick dispersion and indicates the possibility of mitigating effects by cleanup efforts.

Payne, Jim, 1980, Western Gulf of Alaska petroleum scenarios: Kodiak non-native sociocultural impacts: prepared for the Alaska OCS Office Socioeconomic Studies Program, Bureau of Land Management, by Peat, Marwick, Mitchell and Co., Technical Report no. 39, 216 p. Limited distribution through BLM Alaska OCS Office.

The objectives of this study are as follows: (1) to analyze potential impacts and changes in the social systems of Kodiak resulting from projected OCS petroleum development events; (2) to develop necessary understanding of the social systems in Kodiak, including their social organization, content, and current concerns; and (3) to develop an understanding of the social system linkages between Kodiak and higher levels of government. Information is presented in three subsections as follows: (1) a baseline describing the current state of Kodiak's sociocultural system, (2) a projection of where this system will be in the year 2000 without OCS development, and (3) three scenarios building upon the non-OCS projection by adding effects from petroleum development at differing levels.

Peter Eakland and Associates, 1980, Western Gulf of Alaska scenarios: transportation analysis: prepared for the Alaska OCS Socioeconomic Studies Program, Bureau of Land Management, Technical Report no. 37, 274 p. and appendixes. Limited distribution through BLM Alaska OCS Office.

This study examines potential transportation impacts resulting from OCS development activities associated

with Lease Sale 46. Analysis at local, regional, and Statewide levels is included. Existing regional and Statewide transportation systems are summarized, and three base cases, scenarios of the Beaufort Sea and northern Gulf of Alaska (55) lease sales, are analyzed. Measures to reduce negative impacts are not included in the scope of this study.

Terry, J. M., and others, 1980, Northern and Western Gulf of Alaska petroleum development scenarios: commercial fishing industry analysis--Anchorage, Alaska: prepared for the Alaska OCS Office Socioeconomic Studies Program, Bureau of Land Management, Technical Report no. 30, 517 p. Limited distribution through BLM Alaska OCS Office.

This study examines the potential relationships between the commercial fishing and oil industries and projects the potential impacts on the commercial fishing industry of the Gulf of Alaska as a result of proposed OCS Lease Sales 46 and 55. The focus of the study is on the fish processing activities in Kodiak, Seward, Cordova, and Yakutat and the fishing activities in the Gulf of Alaska.

Other Federal Studies

Sears, Howard S., and Zimmerman, Steven T., 1977, Alaska intertidal survey atlas: Auke Bay, Alaska. Limited distribution through National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Auke Bay Laboratory, P.O. Box 155, Auke Bay, AK 99821.

The 402 plates contained in this atlas are the results of an aerial intertidal survey in an effort to classify and provide information on three general littoral parameters: stratum composition, beach slope, and biological cover of the coastline from Yakutat to Cape Prince of Wales. Data on other types of biological phenomena are also recorded and divided into categories for wildlife or vegetation. The plates are arranged in eight geographic areas to facilitate regional usage.

Science Applications, Inc., 1980, Environmental assessment of the Alaska Continental Shelf: comprehensive bibliography: prepared for the Outer Continental Shelf Environmental Assessment Program, 177 p., Office of Marine Pollution Assessment. Limited distribution through Alaska Office, NOAA/OMPA/OCSEAP/MPF24, P.O.Box 1808, Juneau, AK 99802.

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) currently conducts environmental studies on nine lease areas on the Alaska Outer Continental Shelf, ranging from the subarctic northeast Gulf of Alaska to the arctic Beaufort Sea. This bibliography lists all publications resulting from research funded by OCSEAP from its inception in 1975 through January 1, 1980. These publications cover a range of disciplines, including marine geology and chemistry, physical oceanography, biology of marine organisms, and research on the effects of oil on ecosystems. A geographic (lease areas and regions) and discipline index is included. It is intended that the bibliography will be updated periodically.

Science Applications, Inc., 1980, Environmental assessment of the Alaska Continental Shelf: Northeast Gulf of Alaska interim synthesis report: prepared for the Outer Continental Shelf Environmental Assessment Program, Office of Marine Pollution, 313 p. Limited distribution through Alaska Office, NOAA/OMPA/OCSEAP/MPF24, P.O. Box 1808, Juneau, AK 99802.

This synthesis organizes all available marine environmental information

pertinent to OCS development for a given lease area. Information presented includes the following: (1) geological hazards, (2) circulation, (3) chemistry, (4) biology, (5) petroleum industry development, and (6) environmental highlights and issues of the northeast Gulf of Alaska region. A glossary is included.

Other Studies

Arctic Environmental Information and Data Center, 1981, Alaska coastal bibliography and index statewide: prepared for the Alaska Office of Coastal Management, 407 p. Available at cost from Information Services, Artic Environmental Information and Data Center, University of Alaska, 707 A Street, Anchorage, AK 99501.

This bibliography is generated from a data base containing relevant publications, data files, and current research concerning the coastal zone. The research in these documents is intended to help the State's coastal communities in the formulation of their coastal management responsiblilities. Citations can be searched by author, subject, or geographic index (including regions). Citations listed can, in most cases, be obtained for the cost of reproduction. Custom data searches are also available upon request.

NOTE: A list of special collections available on microfiche and a description of the Center's databases are available from the address above.

Hartman, Charles W., and Johnson, Philip R., 1978, Environmental atlas of Alaska (2d ed.): Fairbanks, Alaska. Available at cost from Institute of Water Resources, University of Alaska, Fairbanks, AK 99701.

This atlas provides an overall picture of many aspects of physical Alaska. Five general aspects of the environment are described: (1) physical description of the environment, (2) Alaska waters, (3) light, (4) climate, and (5) engineering information. A selected bibliography is included.

American Association for the Advancement of Science, Alaska Division, and University of Alaska, Institute of Social and Economic Research, 1980, Agenda 80's, proceedings, thirty-first Alaska Science Conference, Anchorage, Alaska, September 17-19, 1980: Anchorage, Alaska. Available at cost from Institute of Social and Economic Research, University of Alaska, 707 A Street, Suite 206, Anchorage, AK 99501.

This document contains abstracts of the 134 papers presented in 34 panel sessions during the conference. The thematic emphasis of the conference was on the social sciences and Alaska's natural resources. Panels concerning OCS-related issues included "Arctic Oil and Gas in National and International Perspective" and "Outer Continental Shelf Studies." The entire Conference Proceedings and full transcripts of the papers will not be published, and it is recommended that authors be contacted directly for selected papers.

Glossary

Definitions presented in the glossary describe terms as they have been used in this summary report. The glossary is intended for general reference only: for detailed descriptions of technical or specialized terms, the reader should seek a reference in the field of particular interest. Abbreviations and acronyms are presented in tabular form on p. ii.

Sources used in compiling this glossary were the Gulf of Alaska Summary Report itself; the Mid-Atlantic, South Atlantic, and Pacific Summary Reports, the Office of OCS Information (formerly OCSIP) Atlantic, Pacific, Gulf of Mexico, and Alaska Indexes; Webster's Third New International dictionary; the American Geological Institute's Dictionary of Geological Terms; and Langenkamp's Handbook of Oil Industry Terms and Phrases (2d ed.).

Anticline - An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

Application for permit to drill (APD) -A document submitted by lease operators for review and approval by the USGS. This application, submitted in conjunction with exploration plans and prior to development and production plans, includes an operational plan for a detailed casing, mud, and cementing program for a specific drilling operation.

Argillaceous rock - Rock having a clay composition.

Basement rock - Rock in the earth's crust beneath all sedimentary rocks.

Basin - A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of the earth beneath which the strata dip, usually from the sides toward the center.

Bedform - Any deviation from a flat bed generated by the flow on the bed of an alluvial channel.

Benthic - Of, relating to, or occurring at the bottom of a body of water.

Block - A geographical area, as portrayed on an official BLM protraction diagram or leasing map, that contains approximately 9 square miles (5,693 acres or 2,304 hectares).

Breakout - Sudden catastrophic local flooding caused by (1) fragmentation and breaking away of a glacial ice-formed dam resulting in the rapid drainage of the glacier-fed lake behind it, or (2) a moraine rapidly draining the lake behind it. This flooding can rapidly transport large chunks of ice into the estuary and out to sea.

Continental Margin - A zone separating the emergent continents from the deep sea bottom.

Continental Shelf - A broad, gently sloping, shallow feature extending from the shore to the Continental Slope.

Continental Slope - A relatively steep, narrow feature paralleling the Continental

Shelf; the region in which the steepest descent to the ocean bottom occurs.

Continental Offshore Stratigraphic Test (COST) well - A well drilled to gather information about the stratigraphic formation present, the general character of the rocks, their porosity, and their permeability.

Decline-curve method - A method used for estimating reserves. It estimates future production by extrapolating plots of actual production rates and fluid percentages into the future; by adding past production to predicted future production, an estimate of original reserves can be obtained.

Development - Activities that take place following discovery of minerals in commercially attractive quantities, including but not limited to geophysical activity, drilling, platform construction, and operation of all directly related onshore support facilities; and that are for the purpose of ultimately producing the minerals discovered.

Development and production plan - A plan describing the specific work to be performed, including all development and production activities that the lessee(s) propose(s) to undertake during the time period covered by the plan and all actions to be undertaken up to and including the commencement of sustained production. The plan also includes descriptions of facilities and operations to be used; well locations; current geological and geophysical information; environmental safeguards; safety standards and features; time schedules; and other relevant information. Under 30 CFR 250.34-2, all lease operators are required to formulate and obtain approval of such plans by the Director of the U.S. Geological Survey before development and production activities may commence.

Diapir - A piercing fold; an anticlinal fold in which a mobile core, such as salt, has broken through the more brittle overlying rocks.

Differential compaction - The relative change in thickness of buried mud and sand (or limestone) due to reduction in pore space.

Discovery - A find of significant quantities of hydrocarbons on a given lease.

Economically recoverable resource estimate - An assessment of the hydrocarbon potential that takes into account (1) physical and technological constraints on production and (2) the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Economic risk factor - The probability that a particular trap will not contain hydrocarbons in sufficient quantities to be commercially productive.

Enclave - An industrial compound physically and socially separated from a community.

Environmental impact statement (EIS) - A document required by the National Environmental Policy Act of 1969 (NEPA) or similar State law in relation to any action significantly affecting the environment.

Epicenter - The point on the earth's surface directly above the focus of an earthquake.

Exploration - The process of searching for minerals. Exploration activities include (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the geologic conditions conducive to the accumulation of such minerals and (2) any drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling of any additional well(s) after such a discovery that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploration plan - A plan based on all available relevant information about a leased area that identifies, to the maximum extent possible, all the potential hydrocarbon

accumulations and wells that the lessee(s) propose(s) to drill to evaluate the accumulations within the entire area of the lease(s) covered by the plan. Under 30 CFR 250.34-1, all lease operators are required to formulate and obtain approval of such plans by the Director of the U.S. Geological Survey before exploration activities may commence.

Fault - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Fault trap - An oil trap whose closure results from the presence of one or more faults.

Field - An area underlain by one or more geologically related hydrocarbon reservoirs.

Finger pier - A jetty or bridge-like structure extending from the shore out into a body of water to permit access to tankers and other vessels, where water depth is not sufficient to allow docking at the shore.

Formation - The primary unit in lithostratigraphy, consisting of a succession of strata useful for mapping or description.

Geohazard - (See **geologic hazard**).

Geologic constraint - A feature or condition posing difficulties for OCS operations that can be mitigated by design and engineering technology.

Geologic hazard - A feature or condition that, if undetected, may seriously jeopardize offshore oil and gas exploration and development activities and, once identified, may necessitate special engineering procedures or relocation of a well.

Geologic risk factor - The probability that a particular trap will not contain hydrocarbons in the quantities predicted by the geologic evaluation.

Geologic trap - An arrangement of rock strata, involving their structural relations or varied lithology and texture, that favors the accumulation of oil and gas.

Glacial lake - A lake formed by glacial meltwater.

Hydrocarbon - Any of a large class of organic compounds containing only carbon and hydrogen, comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons, and occurring in many cases in petroleum, natural gas, coal, and bitumens.

Kerogen - Bituminous material occurring especially in oil shale and yielding oil when heated.

Lease - A contract authorizing exploration for and development and production of minerals; the land covered by such a contract.

Lease sale - The public opening of sealed bids made after competitive auction for leases granting companies or individuals the right to explore for and develop certain minerals within a defined period of time.

Magnitude - A rough measure of earthquake size based on the ground motion recorded by a seismograph. Richter magnitude is calculated by taking the common logarithm of the largest motion (revealed by a deflection on the seismograph) recorded during the arrival of a seismic wave.

Mass movement - Unit movement of a portion of the land surface, as in creep, landslide, or slip. Mass movement, or slumping, can occur where unconsolidated sediments are distributed over a steep gradient.

Moraine - An accumulation of earth and stones carried and finally deposited by a glacier.

Nautical mile - A unit equal to 6,080.2 feet or 1,853.2 m.

Outer Continental Shelf (OCS) - All submerged lands that comprise the Continental Margin adjacent to the U.S. The OCS remains subject to Federal jurisdiction and control after enactment of the Submerged Lands Act (43 U.S.C. 1301 and 1302).

Pacific-Margin Tertiary Province - An onshore and offshore area in southeastern Alaska of approximately 40,000 square miles (103,594 km2) that is underlain by a thick sequence of continental and marine strata ranging in age from Paleocene through Pliocene.

Pay thickness - The vertical extent of the stratigraphic section of an oil field containing reservoir beds that will yield gas or petroleum in economic quantities.

Permeability - The capacity to be penetrated or diffused through; the ability to transmit fluids.

Permeable - Capable of being penetrated or diffused through.

Petroleum - An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoir formations; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

Platform - A steel or concrete structure from which offshore wells are drilled.

Profit share tract - A tract to which the fixed net profit share bidding system is applied. The fixed net profit share uses cash bonus as the bid variable and, in lieu of royalty based on a value of production, requires net profit share payments at a rate that is constant for the duration of the lease.

Province - An area throughout which geological history has been essentially the same or that is characterized by particular structural, petrographic, or physiographic features.

Recoverable resource estimate - An assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

Reserve estimate - An assessment of the portion of the identified oil or gas resource that can be economically extracted.

Reserves - Portion of the identified oil or gas resource that can be economically extracted.

Resource - Concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust.

Rig - Apparatus used for drilling an oil or gas well.

Risked resource estimate - An assessment of oil or gas resources that has been modified to take into account the estimator's confidence in the estimate (i.e., "risked" to account for the probability that economically recoverable resources will actually be found within the area of interest).

Risked, economically recoverable resource estimate - An assessment of oil or gas resources that has been modified to take into account (1) physical and technological constraints on production; (2) the influence of the costs of exploration and development and market price on industry investment in OCS exploration and production; and (3) the estimator's confidence in the estimate.

Royalty tract - A leased tract for which the bidder offers a minimal cash payment but instead proposes to pay the Federal Government a significant royalty on any oil and/or gas profits.

Salt diapir - A structure resulting from the upward movement of a salt mass; oil and gas fields are frequently associated with salt diapirs.

Sandstone - A sedimentary rock made up of sand that usually consists of quartz more or less firmly united by some cement (as silica, iron oxide, or calcium carbonate).

Scoping - A series of public meetings that are held by regional Bureau of Land Management OCS Offices to determine OCS

issues of concern, possible alternatives, and possible mitigating measures.

Seismic - Pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth.

Slumping - (See **mass movement**).

Spud - To begin drilling a well.

Stratum (pl., strata) - A tabular mass or thin sheet of sedimentary rock or earth of one kind formed by natural causes and made up usually of a series of layers lying between beds of other kinds.

Stratigraphic trap - A reservoir, capable of holding oil or gas, that is formed from a change in the character of the reservoir rock. Such a trap is harder to locate than a structural trap because it is not readily revealed by geological or geophysical surveys.

Strike slip margin - A margin in which movement or slip is parallel to the strike of a fault.

Structural trap -A reservoir, capable of holding oil or gas, that is formed from crustal movements in the earth that fold or fracture rock strata in such a manner that oil or gas accumulating in the strata are sealed off and cannot escape. In some cases "structure" may be synonymous with structural trap.

Subsidence - A sinking of a large part of the earth's crust; movement in which there is no free side and surface material is displaced vertically downward with little or no horizontal component.

Subsurface geology - The study of structure, thickness, facies, correlation, etc. of rock formations beneath land or seafloor surfaces by means of drilling for oil or water, core drilling, and geophysical prospecting.

Summary Report - Document prepared by the Department of the Interior pursuant to 30 CFR 252.4 that is intended to inform affected State and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and onshore facilities.

Supply boat - Vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

Tract - The geographic and legal extent of a single lease area; a convenient way of numbering blocks offered for sale.

Trap - A geologic feature that forms a reservoir enclosing and preventing the escape of accumulated fluids (hydrocarbons or water).

Tsunami - A great wave generated by submarine crustal displacement or landslides; associated with major earthquakes and volcanic eruptions. Also called a "seismic sea wave."

Undiscovered resources - Quantities of oil and gas estimated to exist outside known fields.

Volumetric yield method - Method of calculating the bulk volume of a reservoir from interpretation of seismic data and information gained by drilling; porosity of the rock and the relative amounts of oil, gas, and water in its pore spaces can be interpreted through analyses of borehole logs.

Wildcat strike - A discovery of oil or gas in an unproved area.

Zone of convergence - The diminishing interval between geologic horizons, in some cases due to unconformable relationships and in others to variable rates of deposition, the latter applying especially to basin deposits.

☆U.S. GOVERNMENT PRINTING OFFICE: 1981—341-614/201

Outer Continental Shelf Oil and Gas Information Program: Gulf of Alaska and Lower Cook Inlet Summary Report 2

If you find this revised Summary Report useful and would like to receive subsequent Summary Report updates, please provide us with your current address by returning this completed card to our office.

Name _____

Address _____

_____ Zip _____

Organization _____

Comments _____

_____

OCS Oil and Gas Information Program Gulf of [illegible] Report 2 Open-File Report 81-607